Univ. of
Toronto
Library

~~P
Technol
C~~

COMPRESSED AIR MAGAZINE

PUBLISHED BY THE

Compressed Air Magazine
Company

EASTON, PA.

NEW YORK, N. Y.

VOLUME XXI

JANUARY TO DECEMBER, 1916

143314
10/7/17

TJ
951
C7
v.31

INDEX TO VOLUME XXI

JANUARY TO DECEMBER, 1916

A

Accident in Boston Tunnel.............. 8090
Accidents and Popular Beliefs.......... 8094
Acetylene Gas Corrosive................ 7999
“ Lamp Consumption.......... 7902
Aerial Post Service.................... 8191
Aeroplane Carries Supplies to Mine....... 8058
“ Industry, Growth of.......... 8094
Afternoon Inefficiencies................ 7999
Air Balanced Hoisting Engine.......... 8205
“ Blasts in Mines.................. 8108
“ Compressors, Contractors' Portable... 8168
“ Cools Open Hearth Furnaces......... 8062
“ Determines Fineness of Cement...... 7850
“ Friction Speedometer.............. 8021
“ Gun for the Movies................ 8158
“ Hammer Helps out................. 8220
“ in Compression and Expansion....... 7932
“ Instead of Water in Dry Consentrating.......................... 8031
“ Lenses for Diver's Spectacles......... 8039
“ Lift for Ground Water............. 7850
“ “ Hastens Leaching.............. 7958
“ “ at Old Dominion Mine.......... 8023
“ “ in Cyanide Plant.............. 8675
“ “ Power Cost of................. 7960
“ “ Pumping, High Duty.......... 8118
“ “ Quebec Bridge................. 7926
“ “ Raising Oil by................ 8013
“ “ Successful Small............... 8012
“ “ Suggestions................... 7985
“ Mains Convey Water for Fires....... 7850
“ Operated Shovels in Tunnels......... 8055
“ Pressure for Auto Tires............. 7862
“ “ Sprinkling Car........... 8179
“ Propellers for Boats................ 8180
“ Siphon for Gas Retorts.............. 8077
“ Shocks that Kill................8029, 8156
“ Supersedes Steam Calliope........... 8093
“ Tight Brass Castings................ 8175
Alaska, Enlarging a Tunnel in........... 8039
Alloy Steels........................... 7963
Altitudes, Power Losses at.............. 7988
Aluminum in Explosives................ 8191
“ Powdered.................. 8086
Amateur Electricians................... 8127
Ambitions Little Lady.................. 8047
American Port Accommodations......... 8056
Anaconda, Biggest Copper Producer...... 8222
“ Recovery.................... 7903
Artificial Ice in Canada................ 8074
“ “ “ St. Paul, Minn........... 8088
Asphyxiating Horses................... 8222
Atmospheric Humidity.................. 8046
“ Pressure, Health and Comfort........................... 7959
“ Problem in Deep Mines..... 8112
Automobile Plants, Magnitude of........ 7992
Aviation Apprenticeship................ 8195
“ Future of..................... 8121

B

Barometric Low Record................. 7902
Bell Telephone Costs.................... 8157
Belt Tighteners........................ 8011
“ “ Humidity and........... 8102
Belting, Notes on....................... 8099
Beyer Barometric Condenser............ 8081
Big Little David, a..................... 7944
Bigger than the Railroads............... 7992
Black Damp........................... 8152
Blackboard Cleaner..................... 8094
Blacksmith Shop in Alaska Mine......... 8053
Blasted Mosquitoes..................... 8120
Blasting for Clams...................... 8038
“ a Ditch....................... 7999
“ with Liquid Air...........7916, 7996
“ “ “ Oxygen............ 8198
“ for Planting Apple Trees........ 7906
“ Machine, Pocket............... 7902
Blow Guns for Cleaning................. 8030
Blower for Shelling Almonds............. 8092
Blowing Cotton and Wool............... 8093
Blowout in East River Tunnel........... 7962
Blue Print Paper Costs................. 7966
Boiler Explosions in Germany........... 7960
Bontempi Rust-Proofing................ 7913
Brasher Breakwater..........7962, 7980, 8086
Brazil, Rapid Tunnel Drive in........... 8040
“ Statistics...................... 7935
Breaking Boulders by Block-Holing...... 8122
Brown Coal in Germany................ 7965
Bullet, Noise of........................ 7922
Business of Mining..................... 8105
Burning Powdered Coal................. 8144
Bypass on Catskill Aqueduct............ 7843

C

Capacities of Extra Heavy Pipe.......... 7998
Carbide Plant in Norway................ 8031
Carelessness Kills...................... 7988
Catskill Aqueduct Bypass............... 7843
Cement, Air Determines Fineness of...... 7850
“ Gun in Coal Mines............. 8213
“ “ “ Mining Work........... 8107
“ “ for Waterproofing Dam..... 8125
“ “ Work, Cost of............. 7990
Chains, Nomenclature of................ 7966
Chance for Somebody................... 8216
Change of Gas Standard................ 8031
Cheapest Blower....................... 8024
Cherry Pits........................... 8031
Chinaman Runs Drill Sharpener......... 7998
Cleaning Fires by Compressed Air........ 7999
Coal Burned by Railroads............... 8148
“ Burning Powdered................ 8144
“ Cutters in Canadian Mines......... 8085
“ Dust Explosion, Naval............ 8174
“ Miners in British Army........... 8093
“ Powdered, Pneumatic System....... 8175

" Thin Seams, Punchers in 8163
" What there is in 8122
Combination Shot, the 8221
Compressed Air and the Railroads 7897
" at Inspiration Mine 8181
" " at Rockland Lake 8035
" " for Concreting 8055
" " " Sinking a Shaft 8048
" " " Fire Whistle 7984
" " in Construction and Repair 7892
Compressed Air in Mattress Manufacture. 7882
Compressed Air Equalizing at Copper Queen 7885
Compressed Air Lining a Tunnel 7847
" " Pulls by Pushing 7978
" " Safety of in Mining 7858
" " Saves Shoes 8022
" " Solves a Water Problem 8060
Compressed Air Throws Bombs 8158
" " to Save a Park 7929
" " Tunnel Ventilation 7860
Compressor, a Hilarity 8013
Compressors Down in the Mine 7954
" High Speed for Mines 7907
Concrete Conveying, Pneumatic 7982
Concrete Mixer and Pneumatic Conveyor. 8111
Concrete Surfaces, Roughening 8197
Concreting Twin Peaks Tunnel 8189
Condenser, Beyer Barometric 8081
Continuous Gas Light 8190
Contractors' Portable Compressors 8168
Cooling Tower, Largest 8191
" Water for Compressors 8185
Cooperation of Engineers with Government 7945
Copper for Shells 7870
" " High Vacuum 8022, 8126
" Queen, Compressed Air at 7885
Cost of Crosscut Adit 8059
Costs of Mine Haulage, Horses and Air 8116
Cow, Food Productivity of 7965
Cracking of the Hydrocarbons 7994
Current from Sweden to Denmark 7965
Curtain of Air Jets 8055
Cutting off Piles 8157

D

Dam, Largest in Europe 8222
Danger in Copper Carbide Lamp 8024
Dangerous Mine Gases 8076
Deep Hole Drill Wagon 8003
Delay Cartridges 7988
Desiccation, Industrial 8084
Discharge Valve Trouble 7863
Distillate, Produced in Utah 8222
Ditcher and Grader, Railroad 7922
Diver, Narrow Escape of 8084
Diving Hood 8117, 8177
Don't Use Compressed Air 8164
Door Operating Pneumatic Engine 8080
Dover Strait Tunnel 8090
Drill Shanks and Bits 7946
" Steel and its Treatment 7916
" " Handling 7868
" " Resting 7922
" " Shanking 8133
" " Sharpening 8051
" " " at Old Dominion 8018
Drill Steels, Shanking 8133
" Tempering Process 8092
Drills for Cracked Rock 8110
" Tempering 7934
Drilling Contest 8093
" at Treadwell Mines 7976
Drying Air for Sand Blast 8186
" Films for the Movies 7944
Dust Explosion 8094
" " Preventing 8120
" to Prevent Explosions 8015
" Vacuum Conveyance of 8014
" Sand, Wind 8214

E

Earthquake Kills Miners 8092
Economies in Office and Mine 7957
Economy in High Class Equipment 7979
Edison Wireless Telegraphy 7849
Efficiencies of Compressors and Blowers 7952
Electric Air Drill for Blacksmith's Hammer 8050
Electric Air Drill Stamp Mill 7921
" " Heaters in Hospitals 8095
" Cooking of Snakes 8159
" Fans in Winter 8031
" Warm Air Blower 7870
Elephant Butte Dam 8094
Engineer, The 8184
Engineering Explosives 8072
Enlarging a Tunnel in Alaska 8039
Explosives in Engineering 7889
Extra Daylight 8073
Eye Protector Contract 8191

F

Factory Periscope 7960
Falling Pressure Safety Valve 8017
Fans Keep Frost from Windows 7881
Fire Fighting in Metal Mines 8187
" Resisting Materials Sought 8125
" Whistles, Compressed Air for 7984
First Aid in Gas Poisoning 8154
Fish Car 8152
Flags, Pull in Wind 8223
Flotation Parodox 7901
Flying Between France and England 8222
" Machines, Men Employed 7966
Foam Blankets for Oil Fires 8156
Ford Auto Record 8031
Forest Products 8093
Foundation Job, A Typical New York 8103
Freezing of Air Pipes 7866
Fresh Air for Submarines 8190
Frozen Steel, Thawing 7990
Future of Aviation 8121

G

Gage, Inspection, for Hand Drills 8052
Gas from Street Manholes 8221
" Holders, Novel Construction 7960
" Lighting, First in Baltimore 8094
" Main Joint Welding 8069
" Our Dependence Upon 7966
" Well, Greatest Producer 7935
Gases from Explosives 8158

Gassed in the Trenches.......... 8202
Gasoline Cautions.......... 8204
Gasoline Engines, Aggregate Power of.... 7999
" Fires, to Extinguish.......... 8126
" in 1915.......... 8191
" Locomotives Bad for Mine Air.. 7978
" Outfit for Anchor Bolt Holes.... 8106
" Safety in Soldering.......... 8213
" Tanks, Protecting.......... 8094
" Vapor in Air.......... 7895
Give the Compressor a Chance.......... 7948
Glass Blackboards.......... 7869
Gold in Gallipoli Trenches.......... 7869
" " Sulphur Mining.......... 8091
Government Egg Car.......... 8126
Grain Conveyor, Pneumatic.......... 8067
Greatest Pipe Line.......... 7949
" Tunnel in the World.......... 8079
Grouting to Stop Water Flow.......... 7903
Gun, Short Working Life of.......... 8061
" Velocities.......... 8062

H

Hammer Drill Mine Records.......... 8123
Hammers, Steam or Air.......... 8199
Handbook of Casinghead Gas.......... 8187
" " *Rock Excavation*.......... 8218
Hand Drills in Structural Work.......... 8009
Handy Diving Helmets.......... 8177
Hard Hats for Safety.......... 7869
Hay Fever Cure.......... 8093
Heart Action at Great Altitudes.......... 8011
Heating Value of Gas.......... 8223
Hendonhall, Refloating of.......... 7875
High Pressure Gas Feeding.......... 7986
" " Turbo Compressor.......... 8209
" Speed Compressors for Mines.......... 7907
Highest Habitation in the World.......... 8157
Hilarity Compressor.......... 8013
Hoists, Pneumatic.......... 7913
" Portable in Quarrying.......... 8102
Hoisting Engine Air Balanced.......... 8205
How the Windows were Broken.......... 8131
Human Air Pump.......... 8157
Humanizing the Societies.......... 8153
Humidity, Atmospheric.......... 8046
" and Belt Tightness.......... 8102

I

Iodine Dangerous with Mercury Chloride. 7999
Industrial Preparedness..........7964, 8073
Inspection Gage for Hand Drills.......... 8052
Inspiration Mine, Compressed Air at.......... 8181

J

Jackhamers at Pozo Mine.......... 8022
Joking with Compressed Air.......... 7870
Joliet Water Problem.......... 8060

L

Laboratory Wind Tunnel.......... 7880
La Brea Fossil Beds.......... 8074
Lake Titicaca.......... 7965
Lamp for Signals.......... 8061
Lead Mine Given Away.......... 7999
Legal Status of Gas Compressors.......... 8223
Lettering by Sand Blast.......... 8117
Leyner Oil Furnace.......... 7920
Lifting Ground Water by Air.......... 7850
Limestone Quarry, Deep.......... 8157
Lining a Tunnel by Compressed Air.......... 7847
Liquid Air, a Company to Manufacture .. 8093
" " Blasting with.....7864, 7916, 7996
" " Explosives.......... 8027
" Oxygen, Blasting with.......... 8198
Little Tugger Hoist.......... 8177
Livingstone Channel, Dry Excavation.... 8211
Long Distance Advertising.......... 8220
Lung Motors.......... 7869

M

Machine Mined Coal.......... 8222
Marble Quarrying, Technology of.......... 8090
Mattress Manufacture.......... 7882
Mechanical Kinship.......... 7998
Medicine Droppers to Spit on the Hands . 7870
Metal Mining in Bolivia.......... 7876
Metals, War Scatters.......... 7888
Metallic Air Connections in Austria.......... 8031
Metric System Free to All.......... 8217
" " in India Visionary 8126
" " Progress.......... 7993
Mexican Mining Journal.......... 8030
Mine Explosion, Marvel, Ala.......... 8222
" Gases, Dangerous.......... 8076
" Haulage Costs, Horses and Air.......... 8116
" Sprinkling Car.......... 8179
" Timber Treatment.......... 7903
" Ventilation.......... 8077
Mines, Atmospheric Problem in.......... 8112
Miners Phthisis not New.......... 8080
Miniature Air Motors.......... 7902
Mining, Business of.......... 8105
" Code, New One Wanted.......... 7870
" Engineers in the War.......... 7901
Moisture in Fog.......... 8157
Morningside Park Pump.......... 7939
Mosquitoes, Blasted.......... 8120
Motor Cars in America.......... 8093
Mule has Right to Kick.......... 8094
Multiple Effects of Improvements.......... 8057

N

Nails Climb out of Wetted Wood.......... 7999
Nation's Engineers to Help.......... 7897
Natural Bridges in U. S.......... 8222
" Gas Compressors.......... 7931
" " Consumption.......... 8191
" " Pipe Line.......... 7965
New Year Optimism.......... 7865
Nitrogen, Growing Appreciation of.......... 8108
Noise of a Bullet.......... 7922
Norway, Shaft Sinking in.......... 8202
Notes on Belting.......... 8099
"Notowl" for Drying Face and Hands.... 8045
Nova Scotia Steel and Iron Co.......... 8190

O

Odd Job for a Jackhamer.......... 8119
Oil in Air Hose.......... 8026
" Firing Explosions.......... 8062
" Fuel Stored Under Water.......... 7966
" " Supplied at Sea.......... 7902
" Output of the World.......... 8158
" Wells, Air to Help.......... 7902
Oldest U. S. Bureau.......... 8088
One Thing Leads to Another.......... 8188

Digitized by the Internet Archive
in 2010 with funding from
University of Toronto

http://www.archive.org/details/compressedair21wash

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XXI JANUARY, 1916 No. 1

7845

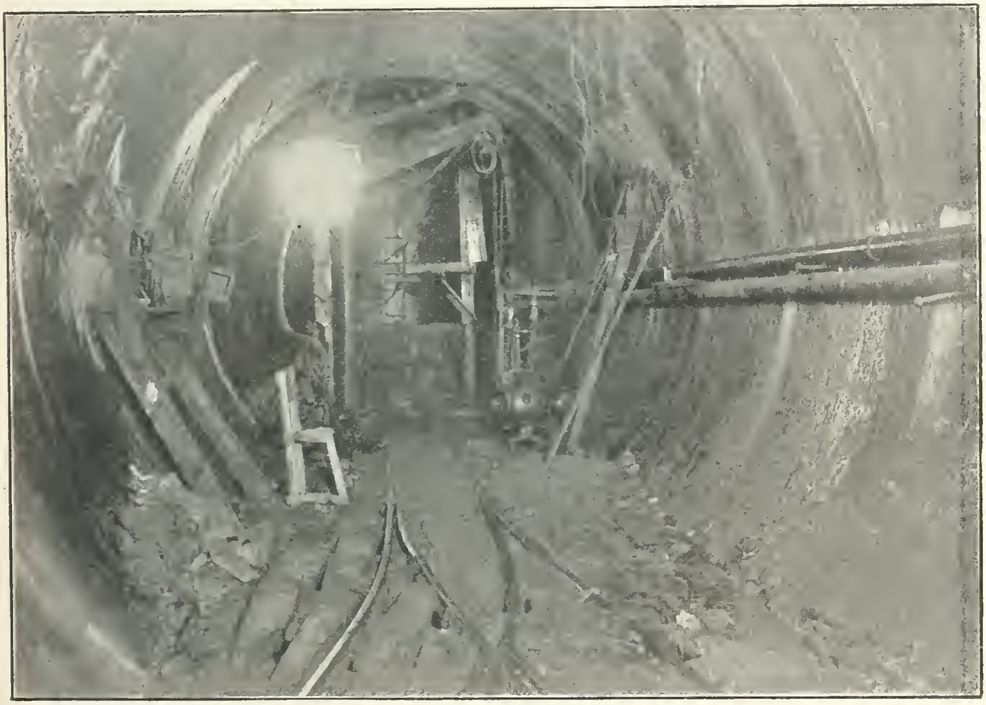


FIG. 2. IN FRONT OF SHAFT 8. DAMAGED PORTION OF OLD TUNNEL.

BYPASS AROUND LEAKY TUNNEL OF CATSKILL AQUEDUCT

BY CHARLES A. HIRSCHBERG.

Driving a shaft and tunnel supplementary to the Moodna pressure tunnel, which connects with the Catskill Aqueduct tunnel under the Hudson River at Cornwall, N. Y., to stop leakage from a damaged section, is practically the last chapter of the gigantic water-supply project of New York City. The work itself is complete now, two months in advance of the time specified by the Board of Water Supply of New York City. There remains only the work incident to tearing out track, cleaning up and sealing the damaged and leaky section. The actual driving and concrete lining of the tunnel and connecting shaft have been finished some time; in fact, the majority of the surface equipment has been boxed and shipped to other work.

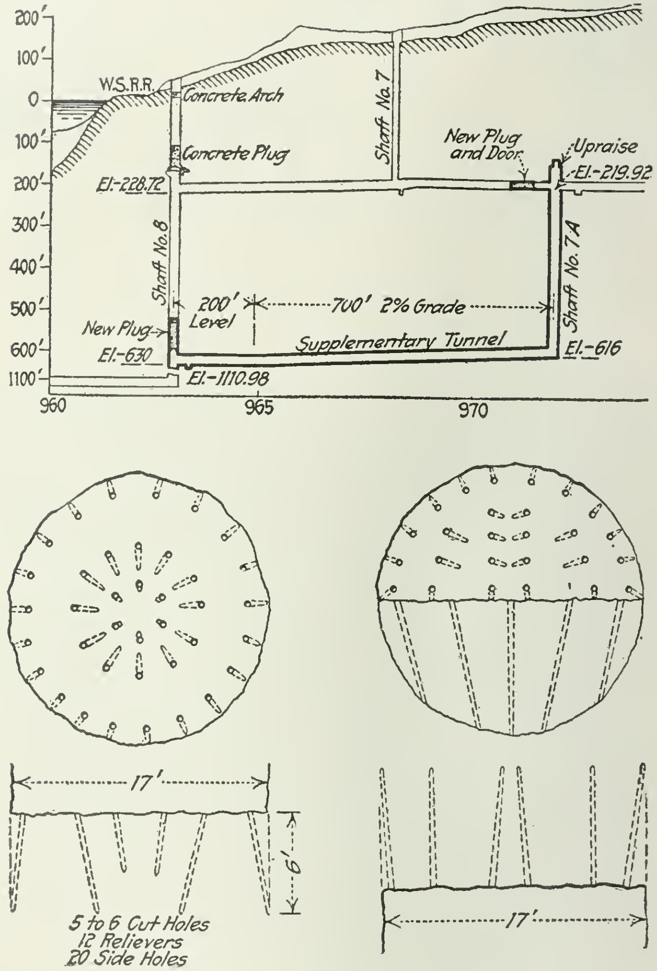


FIG. I.

The original work was carried on through two shafts, known as No. 7 and No. 8, shown in the profile, Fig. 1. No. 8 shaft formed the connection between the siphon under the river and the main water-supply tunnel and had been permanently sealed. No. 7 shaft was driven as an access shaft and was left open to permit operation of the aqueduct. The cracks which developed in the old tunnel are located near Shaft 8 and extend part way toward Shaft 7.

When it was decided to replace the damaged section the plan adopted was to drive a new tunnel section parallel to the old, but located 400 ft. below it. To save time and expense the contractor was required to utilize Shaft 7 (8 ft. 8 in. in diameter) for handling all materials. This necessitated sinking a supplementary shaft (designated No. 7A), 17 ft. in diameter and 400 ft. deep, from a point within the old tunnel and driving a new tunnel 17 ft. in diameter and 900 ft. long. The latter formed the new connection between the siphon and the main water tunnel. A concrete lining reduced both shaft and tunnel to approximately 14 ft. 2 in. in diameter.

PROVISION FOR HANDLING MATERIALS.

The contract was awarded to the Oscar Daniels Co., New York, and the work of installing equipment began in the latter part

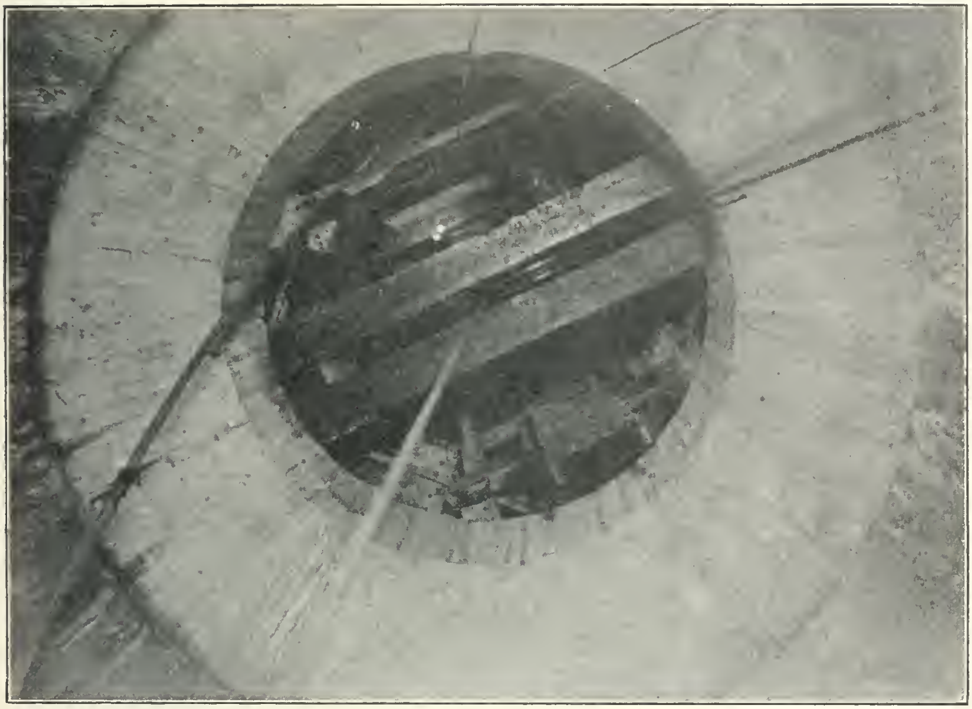


FIG. 3. LOOKING UP INTO UPRAISE OF SHAFT 7A.

of November, 1914. Active work on Shaft 7A was not started until Jan. 2, 1915. The time intervening was devoted to installation of the surface plant, placing guides and apparatus for operating a cage in Shaft 7 and driving a dome or upraise over the location of Shaft 7A for hoisting headframe purposes. Preliminary work also included the installation of a platform at a point in Shaft 8 where the new tunnel was to be started.

It was at first thought feasible also to utilize Shaft 8 for handling materials directly from the new tunnel to the surface. This shaft, however, had been sealed at the top by a concrete dome and also by a concrete plug 50 ft. thick and 30 ft. above the old tunnel, so that the idea of using this shaft was abandoned. Blasting operations for the removal of the 50-ft. plug would have endangered the shaft lining. The concrete dome, however, was removed, and the novel idea was conceived of utilizing the portion of Shaft 8 between the new and old tunnel levels by drilling two 8-in. holes through the plug with a core drill. One hole was used for passing the hoist cable from the surface for handling a cage and the other for chuting concrete for the tunnel and shaft lining.

The tunnel work was prosecuted entirely from Shaft 8.

Fig. 2 is a view in front of Shaft 8, showing, at the left, a portion of the damaged section of the original tunnel.

The first round was blasted on Feb. 6, 1915, and the last or breaking-through round on May 20. Driving the tunnel and sinking the shaft were completed at about the same time.

DRIVING AN UPRAISE.

Fig. 3 is a view looking up into the dome or upraise in Shaft 7A. Work in this upraise, which was 17 ft. in diameter and 31 ft. high, was necessarily slow, owing to the need for continual building of temporary staging, which had to be torn out prior to blasting each round. Work was started on Dec. 31, 1914, and was completed Jan. 17, 1915. Three stope drills were employed for the drilling. The dome was concreted to form a setting for the hoisting headframe with its

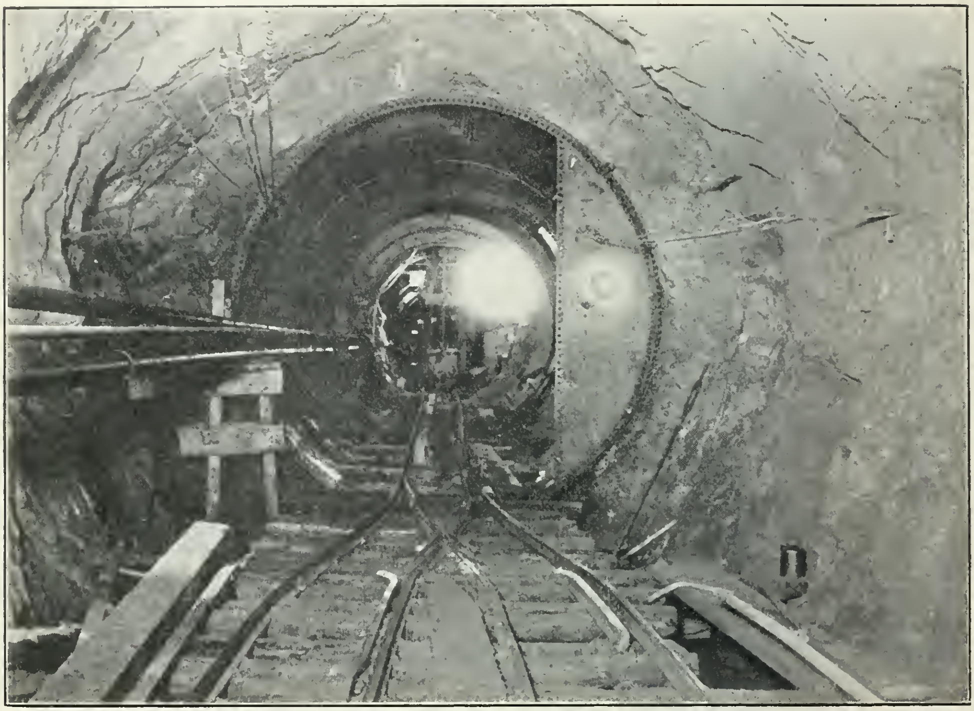


FIG. 4. WHEN NEW WORK WAS STARTED ON SHAFT 7A.

sheaves and to eliminate danger incident to rock sloughing off.

SINKING SHAFT NO. 7A.

In Fig. 1 is a diagram of the drilling round in the shaft. This round consisted approximately of 38 holes. For drilling the shaft as many as six heavy hand hammer drills (Ingersoll-Rand Co. "Jackhamers," Bull Moose size) were employed at one time. The day was divided into one 8-hr. drilling shift and two 8-hr. mucking shifts. All holes were started 2 in. and bottomed 1⅝ in. 1¼ in. powder. The first round in the shaft was blasted on Jan. 22, 1915, and the entire sinking of 400 ft. was completed in 76 rounds, giving an average advance per round of 5.26 ft. After sinking 306 ft., drilling was stopped for 26 days to do concreting, and was resumed again on Apr. 20. In portions of the shaft it was necessary to employ temporary steel lining.

All hoisting in Shaft 7A was handled by bucket, except in the case of the spoil, when the transferable bodies of the 2-ton steel cars were used.

DRIVING THE SUPPLEMENTARY TUNNEL.

The supplementary tunnel, 17 ft. in diameter and 900 ft. long, was driven by the usual heading-and-bench method. The round (in Fig. 1) consisted of 26 to 28 holes in the heading and five holes in the bench.

Work in the tunnel was started from a platform placed in Shaft 8. The first round was blasted on Feb. 6 and holed through on May 20, during which time 206 rounds were drilled, blasted and mucked, giving an average advance of 4.37 ft. per round. The drilling and mucking may be said to have proceeded simultaneously. The first drilling crew worked from 8 a. m. to 4 p. m. and the second from 8 p. m. to 4 a. m., while the first and second mucking crews worked from 4 p. m. to 12 midnight and from 4 a. m. to 12 noon. Holes in the heading averaged from 7 to 8 ft. deep, and from 6 to 8 ft. deep in the bench. All holes were started 2 in. and bottomed 1⅝ in. Changes of steel averaged 24 in. Four No. 18 Leyner-Ingersoll water drills on two columns were employed in drilling and heading. Two drills of the same type set up on tripods drilled the bench. Each machine was manned by two men. About 150 lb. of 1¼-in. "gelatin" was consumed per blast in the tunnel and 90 to 100 lb. in the shaft.

Air was furnished by two 1,200-ft. motor-driven Imperial air compressors, a pressure of 90 lb. being maintained at the drills. The air was conveyed both to the tunnel and the shaft by means of two 4-in. air lines. Water for the drills was taken from the leakage in the tunnel. All haulage was performed by storage-battery locomotives. Lining the tunnel started after holing through. Blaw steel forms being used. The smoothness of the concrete lining of this work is a feature worthy of note.

ENGINEERS AND CONTRACTORS.

D. E. Baxter and C. L. Ostenfeldt supervised the work for the Oscar Daniels Co., S. A. Knowles being Superintendent. The engineers of the Board of Water Supply were George J. F. Carey, Field Engineer, and W. B. Hoke, Section Engineer. Ralph M. Wheeler, Department Engineer of the Northern Aqueduct, was in charge for the Board of Water Supply under the direction of Alfred D. Flinn, Deputy Chief Engineer, and J. Waldo Smith, Chief Engineer.—*Engineering News.*

LINING A RAILWAY TUNNEL BY COMPRESSED AIR

The concrete lining of the double-track Diana tunnel on the Louisville & Nashville R. R. has been placed by the pneumatic system. The tunnel is 1,520 ft. long, in limestone and shale, and required timbering throughout. For about 300 ft. at the north end this timbering had to be removed in advance of the concrete, but for the remainder of the distance the tunnel section was large enough for the lining. Traffic was handled on one track.

Steel forms of the Blaw type were used, with steel plates for the side walls and 2½x5½-in. pine lagging for the arch. The sides were stiffened by vertical I-beams, against which were two lines of horizontal timbers secured to the rock by anchor bolts. Struts from the I-beams carried transverse members, on which were mounted jacks supporting the arch ribs. There were two sections of the forms, each 35 ft. long, traveling on rails. The sides of the forms abutted against the footings, which were built in advance of the forms.

The mixer plant was in the approach cut, about 75 ft. from the portal, working first at the south end and then at the north end. Spoil from the tunnel was crushed to form the coarse aggregate. Sand and cement were delivered by cars and hauled up incline tracks to the top of the material bins. The materials were supplied to a measuring hopper, which delivered 10-ft. batches to the mixer chamber beneath.

An 8-in. steel pipe was laid along the subgrade from the mixer to the forms and then turned vertically, ending in a Y with two 8-in. branches. These branches led into the crown of the arch for about 20 ft., each ending in an elbow at the side wall, with a 9-ft. length of 8-in. hose. Men with ropes pulled the hose to and fro to secure even distribution of the concrete. The concrete was deposited on one side till the wall was 2 to 6 ft. high; then it was diverted to the other side, in order to balance the pressure on the forms.

For concreting the arch, the hose, elbows and one branch pipe were removed and a short piece of hose attached to the remaining pipe. When the concrete reached the end of the hose, this was removed and the concrete blown in directly from the pipe. The forms were left in place for sixty days at first, but afterward the time was reduced to four days.

Where the temporary timbering was removed the cavities were filled with a packing of 55% limestone screenings and 25% sand, blown in by compressed air.

The work was done in 41 sections of 35 ft., containing about 250 cu. yd. each. The concreting of a section averaged 24 hr., with a minimum of 15 hr. The distance for conveying the concrete by compressed air averaged 400 ft., with a maximum of 925 ft. The force consisted of 13 men for concreting and 10 for constructing the footings and shifting the forms.

The work was done by the Meacham Contracting Co., of Hopkinsville, Ky., using the McMichael pneumatic plant supplied by the Concrete Mixing and Placing Co., of Chicago. It was under the supervision of H. C. Williams, Chief Engineer of Construction, Louisville & Nashville R. R. George B. Bryson was Resident Engineer.—*Engineering News.*

DEEP DIVING RECORD

In the raising of the ill-fated submarine F-4 in Honolulu harbor from a depth of 300 ft., a new world record for deep diving was made, as described by Naval Constructor J. A. Furer in Engineering News.

It was possible to send men down to this previously unattainable depth only by the use of special methods. The Bureau of Construction and Repair of the Navy Department had been experimenting for some time on deep-sea diving. It so happened that these experiments were brought to the point of practical application just before the accident to the F-4. Four divers, in charge of the officer who had been conducting the experiments, were ordered from the New York Navy Yard to Honolulu for this work.

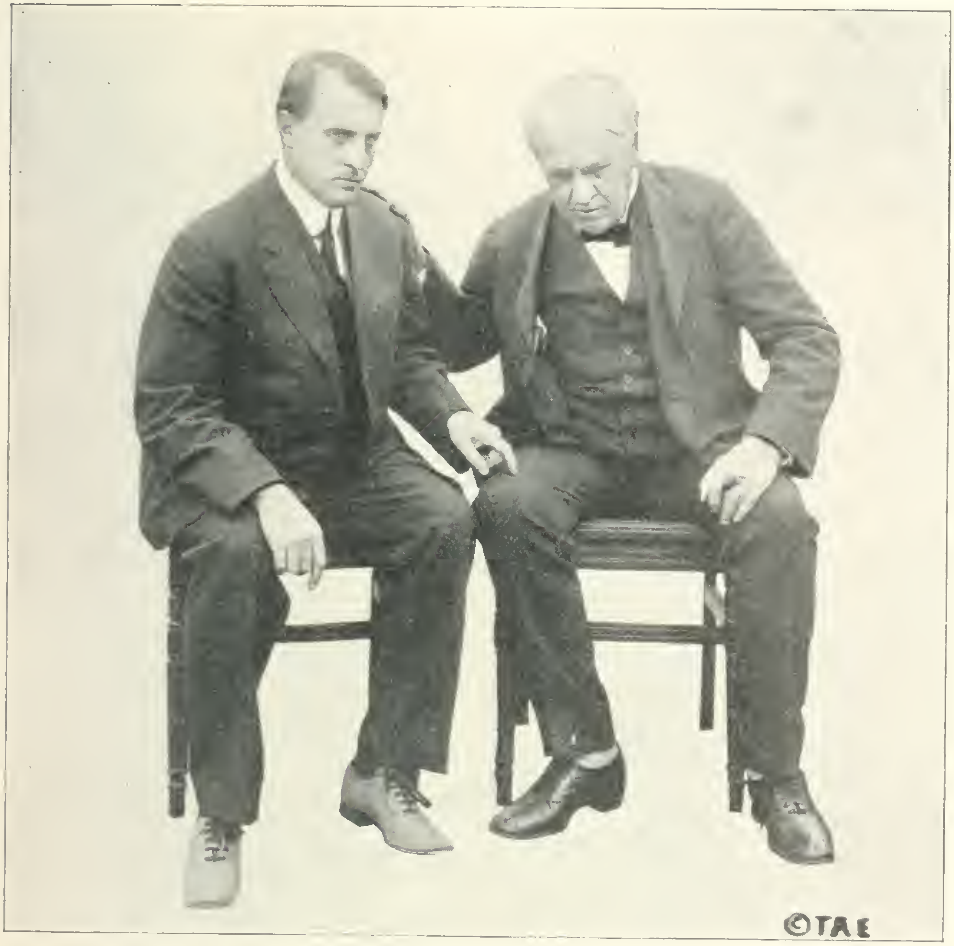
The diver does not wear a suit of special character for working in great depths. The difference as compared to shallow-water procedure lies entirely in the method of supplying air to the helmet and in the scientific restoration of the diver's body to the normal state by gradual decompression as he comes up from deep water. Air is supplied from flasks charged to a high pressure—suitably reduced before being delivered to the diver's helmet. The dangers in deep-sea diving are due principally to the absorption of nitrogen by the fluids of the body, on account of the high pressure to which the lung tissues are subjected, and to the extreme exhaustion accompanying any kind of manual labor. For the latter reason the divers could not do heavy work at the 300-ft. depth, such as can easily be done by men working in shallow water. Their duties had to be limited to observing and reporting the conditions found below.

WAR CONSUMPTION OF METALS

Here is a single item suggesting something of the enormous consumption—the practically total disappearance—of the industrial metals used in modern "civilized" warfare. A British 18-pounder, or 3.3 in. shrapnel, requires 5 lbs. 9⅛ oz. of brass, containing 66% to 70% Cu. or nearly 3¾ lbs. A small copper band around the shell adds 4¾ oz., making the total copper 4.04 lbs. Spelter-consumption per shell of this size is about 1.87 lbs. Lead bullets weighing 7.92 lbs., and composed of 7 parts of Pb to 1 Sb, constitute the metal load of the projectile. Estimating the total orders for shrapnel and other shells placed in the United States by Europe at 25,000,000 shells, these orders would call for a total of 101,000,000 lbs. of copper, 46,750,000 lbs. of spelter, and 173,250,000 lbs. of lead. Actually the metal consumption is larger, as a fair proportion of the shells are 4.7-in. Howitzer shells, using more brass; some 6-in., 7½-in., and probably 9-in. shells are also being made. Rifle cartridges are composed mainly of copper, there being 1 lb. of it used in making 24 Lebel cartridges, a type widely used by the French army. Every 125 of these cartridges consume 1 lb. of spelter and a small amount of nickel. Steel consumption per shell varies more widely with the different types. A finished 3.3 in. shell contains 6 lbs. 15¼ oz. of steel; the steel shell weighing 6 lbs. 5¾ oz., and the diaphragm 9½ oz. If the shell is made from a steel bar, the weight of this is about 17 lbs., while a forging for the same purpose weighs approximately 14½ lbs., and a "bottle" made by the seamless tube process somewhat less.

DYNAMITE DITCH DIGGING

A ditch 400 ft. long and 12 ft. wide was recently dug with dynamite at Carney's Point, N. J., in one day at a cost of 15 cents per cubic yard. The ditch was across a mud flat from a sluice gate to the Delaware River. The ground was soft, water-filled mud covered with a dense growth of reeds. These were first cleared off for a width of 15 ft. along the line of the ditch. As the ditch was to be only 4 ft. deep, the holes were made by pushing a long shovel handle down full length. Three rows 4 ft. apart were made, with the holes 18 in .apart and 3 to 4 ft. deep. Each hole was loaded with two cartridges of 60 per cent. dynamite, one at the bottom and one about 18 in. from the top. Some of the holes in the middle row were loaded with three cartridges, two at the bottom and one 12 or 15 in. from the top. Electric blasting caps were placed every 50 ft., and fired with a No. 5 blasting machine. The result was a perfect ditch, which filled with water at high tide, 3 hours later. The dynamite cost $120 for the 800 lb. used, the exploders 50 cents, and the four men who did the work were paid $8, making a total cost of $128.50.



THE WIRELESS TELEGRAPH AT WORK.

EDISON WIRELESS TELEGRAPHY

The excellent photo here reproduced tells its own story very completely. It is well known that Mr. Edison is so deaf that he hears practically nothing of what is said at a public meeting so that he is accompanied at such places by Dr. Miller Reeves Hutchison, E. E., Ph.D., "Chief Engineer to and Personal Representative of Thomas A. Edison," who communicates with him constantly by tapping with his finger on wrist or knee as here shown, using the Morse code. It is well known that Mr. Edison's first activities were as a telegraph operator, so that communication by this means is like play to him.

Dr. Hutchison, of course, attends all meetings of the Naval Consulting Board with Mr. Edison, and has been made a member of that body. He recently gave an address on the Life of Thomas A. Edison before a gathering of electrical engineers at the close of which he invited questions which brought out many phases of the private life and the dominant human element.

Mr. Edison finds no pleasure in horseback riding. He tried it once and got enough. Desiring to master the art immediately he spent a considerable time in riding his steed before dismounting. The resulting discomfiture and inability to sit down without an ache for a week discouraged all future efforts. Mr. Edison seldom smokes, considering it effeminate, and that it is far more masculine to chew. He cares little for publicity and counts his deaf-ness as his greatest fortune. At public dinners Dr. Hutchison keeps him informed of what is said, and at a recent affair when unlimited praises were dealt out, Mr. Edison promptly telegraphed back, "Oh, hell." Mr. Edison is quick also at other styles of repartee, and seldom misses an opportunity for a flash of wit.

AIR TO DETERMINE THE FINENESS OF CEMENT

In the mechanical analysis of cement it is not practicable to use a sieve finer than 200 mesh. Most specifications require that at least 75% of the cement shall pass the 200 mesh but even then some of the material might still be too coarse to be acted upon by motor, and it thus would be practically inert materials. For a finer separation, elutriation methods in which the desired separations are accomplished by washing or blowing, are necessary. J. C. Pearson and W. H. Sligh discuss this matter in Technological Paper No. 48, recently issued by the Bureau of Standards.

Two types of apparatus are used, one employing a liquid and the other a gas. Gas or air-analyzers are believed to be the best for cement, and the investigations of the authors were confined to this type. After a series of experiments with the kinds of apparatus at present in use, an analyzer was developed that gave reliable results which could be used as a basis for comparison with tests made with other analyzers. It was possible to separate the finer material into particles having an average diameter of 0.001 in., 0.002 in., and 0.003 in. respectively, and the determinations were accurate within 2%. While the investigation has so far been rather fragmentary, enough has been accomplished to show the importance of a more complete analysis than can be obtained by the use of sieves, especially in the study of the effects of fine grinding. The air-analyzer can also be used in studying the properties of other powdery materials than cement.

At the Mount Morgan mines in Australia, the air mains can be supplied with water for fire fighting purposes. The water is under a high pressure and this idea has been found highly satisfactory.

LIFTING GROUND WATER BY COMPRESSED AIR*

The purpose of this paper is to describe in an elementary way the present condition of the art of lifting water from wells in the ground, usually driven, by the use of compressed air. This is commonly called the air lift system as distinguished from direct mechanical pumping.

All water distributed over the earth is normally rain water, and that found in the ground is what has not been carried to the sea by the rivers. In the western part of the United States the rainfall is much less than in the eastern portion and much of the rain goes into the ground, percolating through the sands, porous rocks and fissures, while that over the surface rapidly evaporates, leaving the soil dry. In the east with more rainfall and less evaporation the soil remains more moist but much water runs into the lakes and streams which carry it to the ocean. It has been estimated that from 80 to 90 per cent of the rainfall finds its way beneath the surface of the earth, some of it to great depths, yet vast volumes are easily recoverable by pumping from driven wells with suitable apparatus.

Water was first obtained from the earth strata by dug wells and lifting buckets. Later on endless chains were introduced, followed by screws and other mechanical devices, until the piston pumps, first operated by hand and later by mechanical devices, replaced the earlier systems because of the increased volumes obtained.

The old-time well, although widely employed, was of limited capacity and usefulness. It could not be dug to great depths and hence the art of well driving, as distinguished from drilling, was developed, and now the driven well has replaced the open well for nearly all practical purposes. Driven wells may be carried to great depths, thousands of feet, tapping successively several subterranean streams and thus obtaining a great aggregate from the one installation.

---

*Paper by W. L. Saunders, presented at the second Pan American Scientific Congress, Washington, D. C., Dec. 27, 1915—Jan. 8, 1916.

The term "artesian" applies to driven wells which tap communications with natural reservoirs of water such as lakes or other bodies of water situated at a distance and at a higher level than the well itself, but all deep wells are not necessarily artesian. They may connect only with subterranean strata containing rain water, the advantage of the depth being in the increase of the volume of supply, the level of the water in the well rising to such a point as is represented by the various depths of the underground streams.

[The description of the operation of driving these wells and of the various devices employed, as embodied in the paper, cannot be printed here on account of lack of space. Ed. C. A. M.]

Having drilled the well we may at times find that it flows at the surface, but this flow may not be sufficiently rapid to give the desired capacity, hence, even in normally flowing wells, the general practice is to pump. The pumping action almost invariably lowers the level of the water in the well to a certain point where it then remains approximately stationary when the pump is at work. This condition indicates and fixes the normal capacity of the well.

Before the invention of air lift systems the practice was to lift the water by mechanical means; that is, by a pump located at or below the surface, according to the level of the water in the well, the pump sometimes being constructed to go down to considerable depths in the well, the water being lifted by the pumping action of pistons operated by mechanical means through steam, hydraulic, electric or other sources of power.

Every system of mechanical pump action is limited in its capacity and incapable, except in large units, of giving at times the full water capacity of the well. It requires attention, is subject to wear and tear, and where the apparatus is located underground it cannot be readily adjusted, and, as water is not a good lubricant, the wear and tear is an item of consequence.

The air lift system removes all mechanical action from the well itself. There are no valves or reciprocating parts within the well to clog or get out of order. All the apparatus is located on the surface, in a clean, light engine room, where it is seen and cared for by a competent mechanic. All that goes into the well is a system of piping arranged to receive compressed air, which is carried down to a considerable distance below the level of the water.

The first and simplest form of air lift is that known as the Frizell system, a system which will not be illustrated or described

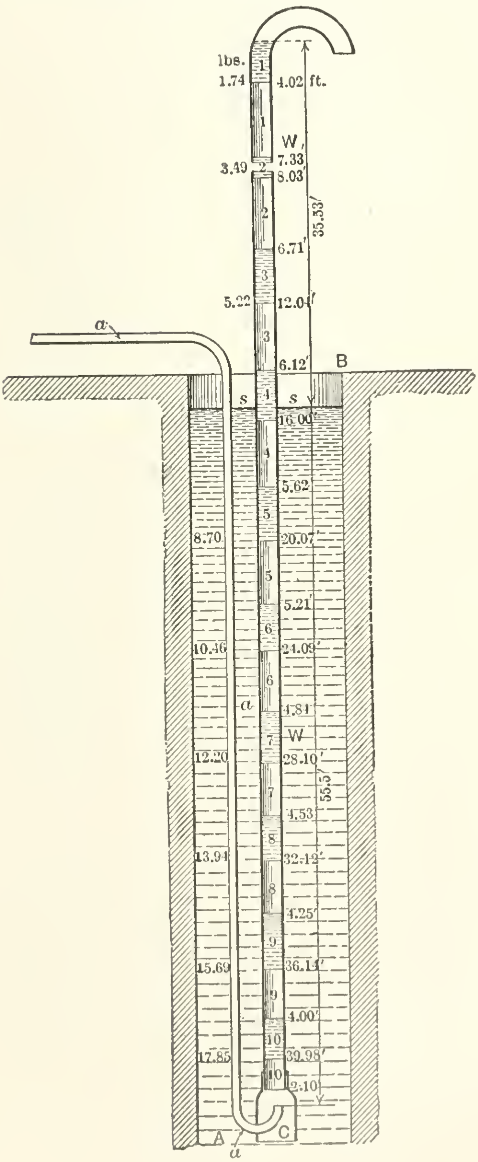


FIG. I.

here because it has never been generally used. The Frizell system gave the first thought to pneumatic engineers, who carried the air lift many steps further, and made from what was little more than a laboratory experiment a practical and useful system of pumping. Frizell introduced bubbles of air into a pipe, which was inserted below the level of the water in an open ended pipe which was also inserted below the level of the water, the air being injected at or near the bottom, thus aerating the air within the pipe, giving it, as it were, a champagne appearance, which lightened the column of water in the pipe.

The first successful air lift used on a large scale is known as the Pohle system. Following this came the Saunders system. All other air lift pumps, and there are many of them in practical operation, involve more or less modification of apparatus, but the principles governing them may be found in either the Pohle or the Saunders system.

The Pohle air lift pump is shown in Figure 1.

The Pohle system is briefly described as follows:

Two properly proportioned pipes are placed in a well, the one an air pipe leading from the Air Compressor and connected with the other pipe, the water discharge pipe, near its base through what is known as the foot—or end—piece. The compressed air is forced through the air pipe into the foot piece and the water pipe, and by its inherent expansive force, layers or pistons of air are formed in the water pipe, which lift and discharge the layers of water through the upper end of the water discharge pipe above the water level of the well.

At the beginning of the operation, the water surface outside of the pipe and the water surface inside of the water pipe are at the same level; hence the vertical pressures are equal at the submerged end of the pipe, outside and inside. As the compressed air is forced into the lower end of the water pipe, it forms alternate layers with the water, so that the downward pressure of the column thus made up of air and water, as it rises inside of the water pipe, is less than the pressure outside of the pipe. Owing to this difference of pressure, the water flows continually from the outside to within the water pipe by gravity, causing the column of air and water to rise, and its ascent through the pipe is free from shock, jar, or noise.

As each air stratum progresses upwards to the spout, it expands on its way in proportion as the over-lying weight of water is diminished by its discharge, so that the air pressure, which may have been, say 50 lbs. per square inch at first, will be only 1.74 lbs. when it underlies a water layer of four feet in length at the spout, until finally this air section when it lifts up and throws out this four feet of water, is of the same tension as the normal atmosphere.

The foregoing is the theoretical action of the Pohle pump. Practically it does not follow the lines indicated, due to slippage of the water pistons through the air bubbles, but mainly because of improper design of the piping system, and the proportion which the air pressure bears to the head of water.

When the compressed air is forced to a point within and at the lower end of the open ended discharge pipe the first effect is to blow out, en masse, the entire volume of water within the discharge pipe, which action naturally produces a vacuum effect within the pipe, the result being that the water surrounding the pipe rushes in, is caught by the incoming air pressure, and thus an intermittent struggle takes place between the head of water outside the eduction pipe and the pressure of compressed air, one first gaining supremacy and then the other, but all moving upward through the eduction pipe because of the momentum given the entire mass through the first impulse created by the air.

Many attempts have been made to develop mathematically theories of the air lift pump, but it is doubtful whether any of them are correct because of uncomputable conditions. If no slippage took place within the discharge pipe, or, in other words, if the air followed the water in well defined piston layers from the time it started at the bottom until it reached the surface, there would obviously be an action equivalent to that of a perfect expansion engine.

Such conditions are impossible of attainment, and even if obtained the air bubble might be larger than required to discharge the maximum quantity of water, hence it has been found best to split up the air before it enters the discharge pipe, and for this pur-

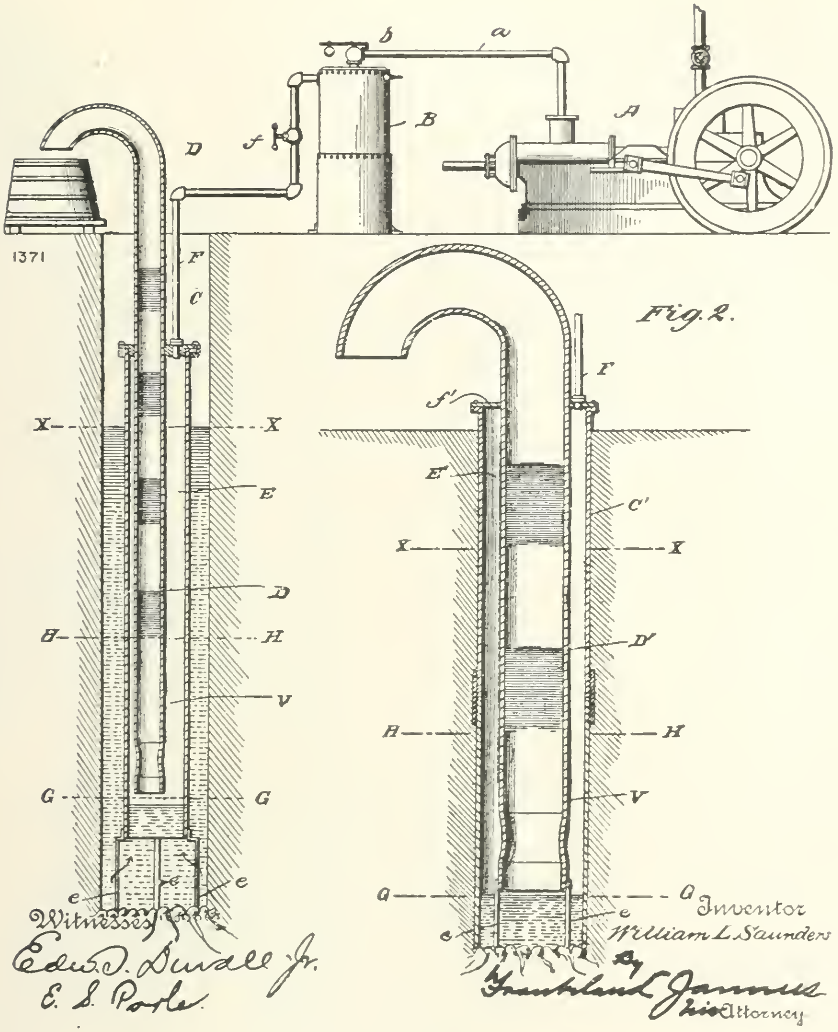


FIG. 2.

pose perforated screens or foot pieces are used, which serve during the constant operation of the pump to permit only as much air to be blown into the water column as will be sufficient to keep this column moving upward to the point of discharge.

When the pump is first started it is likely that in order to blow out the column en masse most or all of these perforations are in action and an uneconomical condition exists, but this is only momentary, because after the first impulse the relation between the head of water, the diameters of the pipes and the air pressure establishes a state of equilibrium which automatically causes the water to cover some of the lower perforations and in this way to restrict the admission of compressed air to that only which is required to keep the aerated column moving upward.

Figure 2 shows the Saunders system. In this there is a pressure chamber, formed either by a well casing or through an open ended air chamber surrounding the eduction pipe. The air is admitted to this pressure chamber, forcing the water downward until

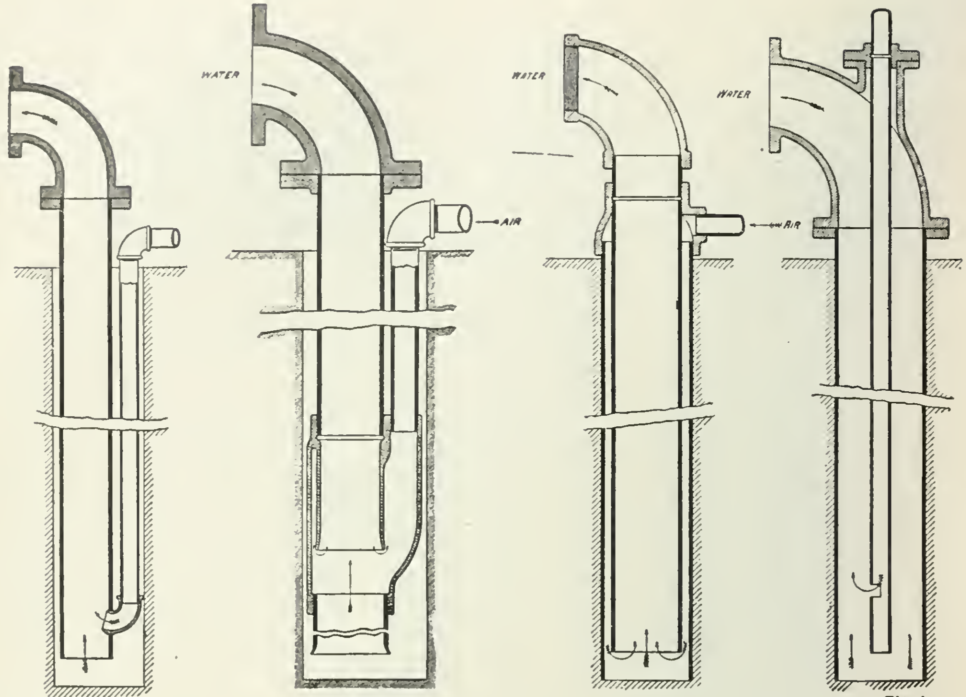


Fig. 1 Fig. 2 Fig. 3 Fig. 4

FIG. 3.

its level is at or below the open end of the eduction pipe. At this point the compressed air from the chamber enters the discharge or eduction pipe and this loss of air escaping upward slightly lowers the pressure of air in the chamber, which causes the water to rise to a point balanced by this pressure loss. This action causes the water to again cover the lower end of the discharge pipe, and the air accumulating in the chamber again lowers this level, and so an intermittent action or pulsation of air and water takes place, alternately cutting off the air and water and causing columns or chunks of air and water to rise within the discharge pipe. The action of this pump has been shown in glass models to be as described, air being blown in steadily and the water rising in the discharge pipe in well defined sections, mixing with the air only at or near the surface or upper end of the pipe.

In a glass model, capillary attraction causes a more perfect division between the air and water, but the main point is that it shows the pulsating action. The best designs for this system do not admit the air to the open end of the water discharge pipe but through perforations made laterally at or near the lower end of this pipe. These perforations split up the air and prevent waste through large bubbles which cause slippage.

Perforated foot pieces are now used in all air lift systems in order to effect economy in the use of air, as in fact the air required is only that which is sufficient to keep the discharge column of air and water moving upward in a steady flow.

Figure 3 shows the various methods of piping wells when using either of these two systems described. The two outer methods of piping marked Fig. 1 and Fig. 4 (in Figure 3) are the Pohle systems, and the two central ones, Fig. 2 and Fig. 3 (in Figure 3) the Saunders system. Fig. 4 (in Figure 3) shows a well piped by what is known as the central pipe plan, which instead of admitting the air pipe alongside the water pipe admits it through the center to a point near the bottom of the discharge pipe, the air being admitted by simply cutting a hole in the side of the pipe. Fig. 2 (in Figure 3) shows a well piped by the Saunders system with a cast iron chamber placed at the bottom of the discharge pipe, the air being admitted on the outside of this pipe and into the chamber near the bottom of the well.

Fig. 3 (in Figure 3) shows this system where the well casing itself serves as an air chamber, the compressed air pipe entering at the top or near the surface of the ground.

ARRANGEMENT OF WELLS AND PIPING.

Proper piping up of wells is a feature counting largely in the success of an Air Lift system, whether working one or several scattered wells. The introduction of unnecessary valves, elbows, angles and bends will cause a loss of air pressure, cut down the efficiency of the plant very largely, and should be avoided as far as possible.

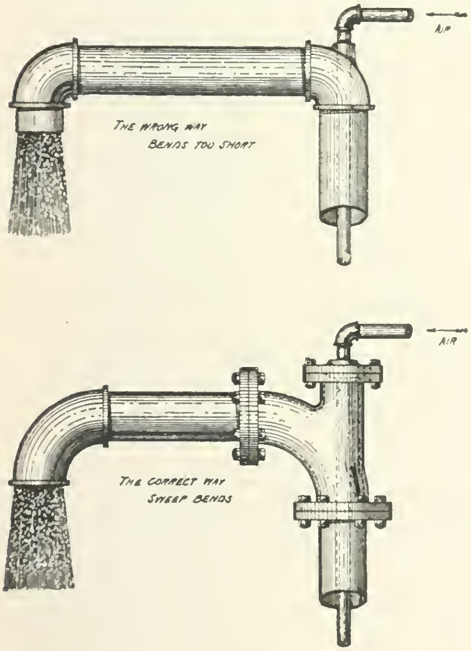


FIG. 4.

It is therefore well to lay out beforehand the wells and piping, placing the wells and reservoir so that pipes can be run direct, with the fewest possible bends, elbows and valves. Pipes should all be made of a size sufficient to carry air to the wells and the water away with the least practical resistance.

The tables available afford a means of determining the sizes of pipes necessary to transmit a given volume of free air with a predetermined drop, or conversely, the reduction of pressure which will occur in a given length where a certain size pipe is used. To the actual lengths, as measured from plans, or on the ground, should be added the increase or allowance for valves, tees and elbows, as given in the tables. It is for this reason that the use of long sweep elbows and tees is recommended, especially for water. In many cases elbows can be avoided by making long bends of pipes. If this is done, the bends should be made smooth, regular and free from dents or kinks.

Figs. 5 and 6, showing typical air lift pumps installed in wells, illustrate clearly the method of piping.

Fig. 5 shows a Class "VA" pump discharging directly into a concrete basin set over the well. From this basin the water either flows by gravity to its destination or is pumped to a stand pipe or storage tank. The deflector or "umbrella" head piece will be noted; this deflector causes the water to flow along natural lines, minimizes resistance and results in increased efficiency; it can be supplied for either the Class "VA" or "VC" pumps in standard sizes for pipe up to 8-inch diameter and in special sizes to any diameter.

Fig. 6 shows a Class "VC" pump designed to discharge into a tank some distance from the well, the 90-degree head piece shown has a long sweeping bend, and can be supplied for any size well desired.

Fig. 7 shows a special adaptation of the central air pipe system. In this type the air and water are mixed in a "mixing chamber" at relatively low velocity, from this they enter the eduction pipe through a reducing nipple which increases the velocity to that for which the pump was designed. After leaving the well the water passes off through pipe B, the air escaping through pipe A. The air from pipe A is sometimes piped back to the compressor intake so as to take advantage of its low temperature.

As the air pressure required with an air lift pump depends upon the submergence, it follows that the starting pressure is higher than the running pressure. In some wells the difference between the static and pumping heads may be sufficiently great to make the starting pressure so much higher than the running pressure as to seriously overload the

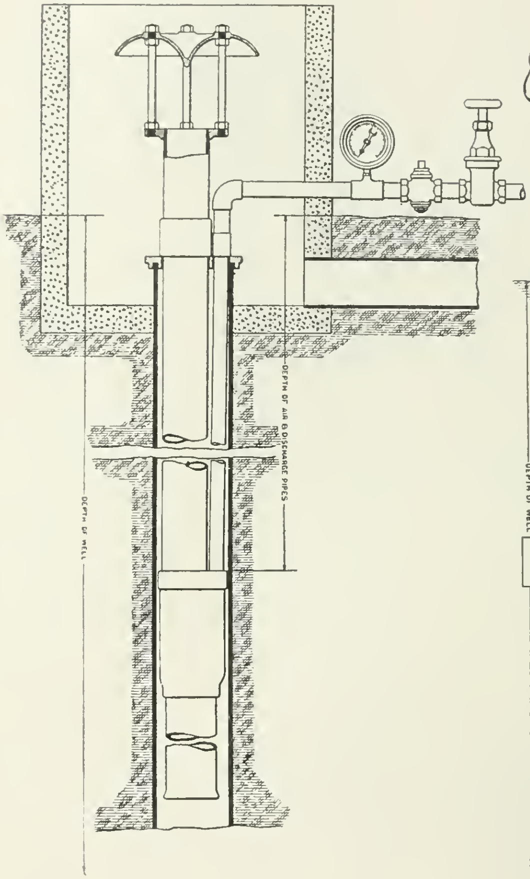


FIG. 5.

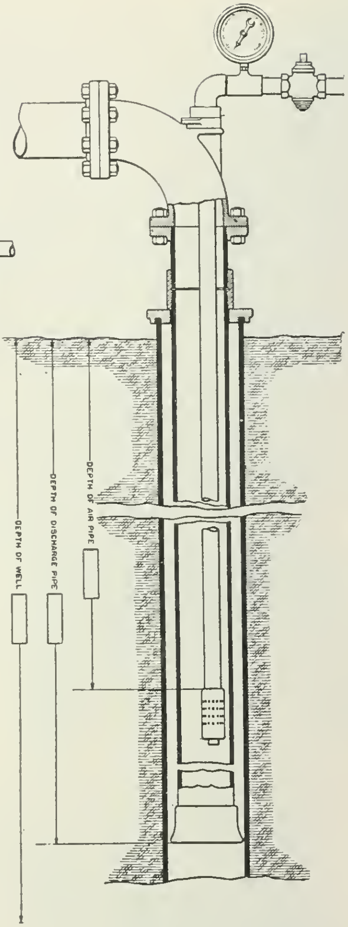


FIG. 6.

air compressor. Air compressors are designed for maximum economy at the average air pressure which, in an air lift pump, remains constant while the pump is in operation, the capacity for overload is limited and it is dangerous to exceed the limit. In Fig. 8 is shown an arrangement known as the compound air lift which will overcome this difficulty. It consists of a standard air lift pump with a special auxiliary or starting pump placed so that its submergence, with respect to the static head, will be such as to utilize the maximum pressure which the compressor is capable of without dangerous overload. When starting a well the air is first turned on to the auxiliary pump and, as the head lowers, the standard pump comes into action and the auxiliary pump is gradually turned off. This arrangement is of course special and requires special engineering.

REGULATION OF AIR SUPPLY.

When running several wells together which require different air pressures, engineers sometimes put throttle valves on all the wells and in regulating them too finely raise the receiver pressure to a point far above that required to run the highest pressure well. All this excess pressure represents power thrown away, and the practice should not be allowed. It is in such cases necessary to have throttle valves in all the low pressure wells and to often have them nearly shut, but the well that requires the highest pressure to operate it should be run with the valve wide open, or nearly so, and then the other wells regulated to take what air they need, forcing the rest of it to the high pressure well.

An orinary globe valve proves to be the best regulating valve except for very high pressures. Gate valves or plug cocks cannot be regulated as closely and cannot be so readily set at the same point after having been closed. A second globe valve may be used for stopping and starting, thus leaving the economical adjustment of the regulating valve undisturbed.

The brief descriptions just given call attention to a few working combinations, but by no means exhaust the arrangements which can be made. They will suffice, however, to illustrate the wide applicability of this means of raising water.

CONSIDER FUTURE DEVELOPMENTS.

In certain districts, where the water level is continually falling, it is advisable to install higher pressure equipment than would otherwise be required, so as to care for the greater air pressure necessary for the constantly increasing lift.

Economy is the most important factor when considering the installation of an air lift plant. Air compressors may be had to compress air as high as 100 pounds in a single stage, but in order to realize the greatest possible economy two stage compression should be resorted to for all pressures over 70 pounds, while in cases where the pressure is liable to increase, due to the falling water level, two stage compression should be used for pressures as low as 60 pounds. The greater operating economy easily offsets any slight increase in first cost.

In order to check the slippage of pump, a test was run on the reservoir with the wells alone, stopping the pump.

Time of test, minutes	15
Water lift in reservoir increased, inches	16
Gallons pumped per minute	3666

Size of compressor used—

Steam cylinder, 20 & 34 ins.
Air cylinder, 32¼ & 21¼ ins.
Stroke of all cylinders, 27 ins.

Cu. ft. displacement in compressor per revolution	23.77
Average revolution per minute	66.6
Cu. ft. free air per minute displacement	1583

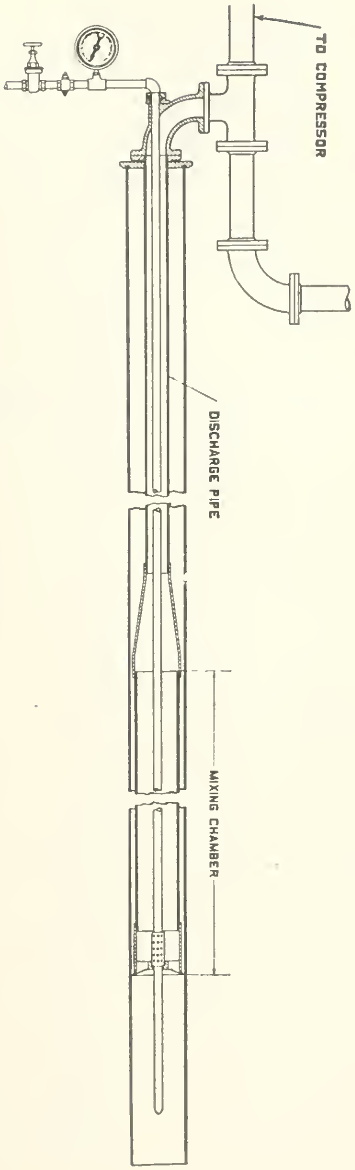


FIG. 7.

3666 gallons per minute lifted 89.5 feet equals 82.85 W-H. P.

W-H. P. divided by I-H. P. equals 39.26 per cent. efficiency.

The simplicity of the air lift system is seen in the fact that the entire plant required is an air compressor with any driving means and an air receiver from which the com-

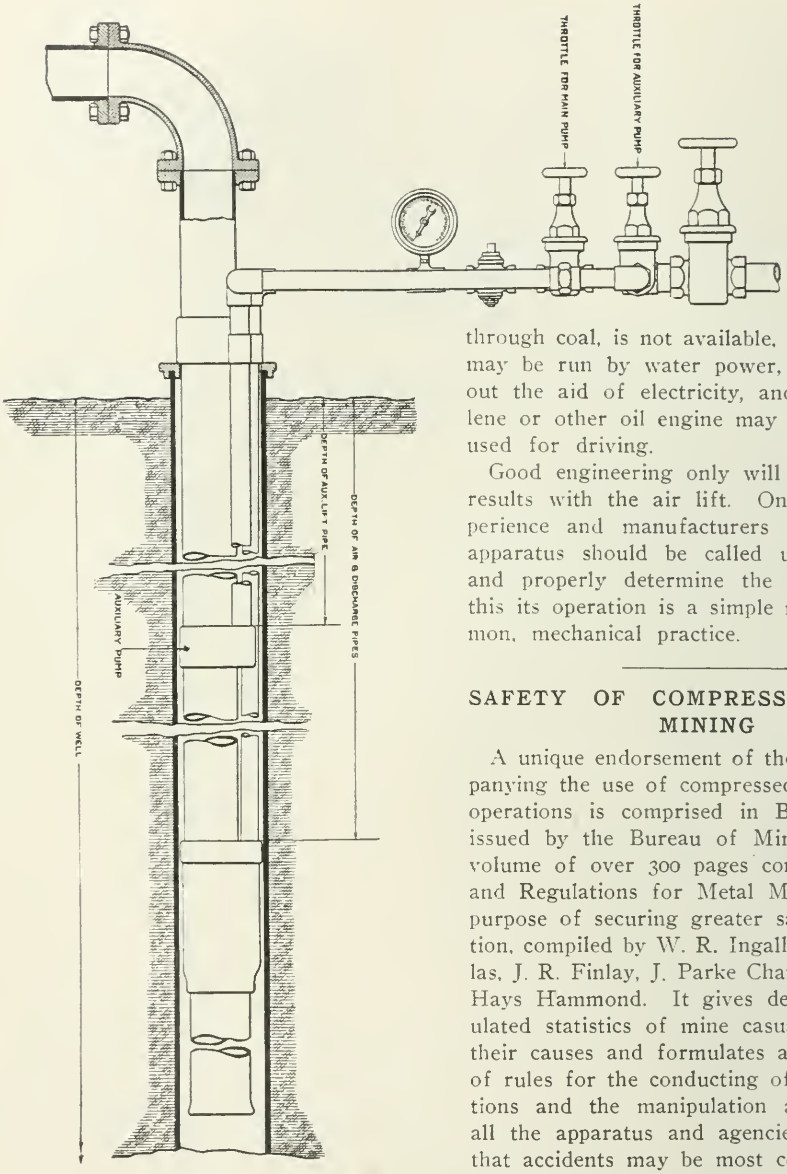


FIG. 8.

pressed air is led to the well in the ground. The only other apparatus is the piping. In some cases special foot-pieces are used, but they are simple castings or tubes.

It is thought that this system should appeal specially to Latin American countries because of the fact that where steam power, through coal, is not available, the compressor may be run by water power, with or without the aid of electricity, and also a gasolene or other oil engine may be successfully used for driving.

Good engineering only will bring the best results with the air lift. Only men of experience and manufacturers of high grade apparatus should be called upon to advise and properly determine the details. After this its operation is a simple matter of common, mechanical practice.

SAFETY OF COMPRESSED AIR IN MINING

A unique endorsement of the safety accompanying the use of compressed air in mining operations is comprised in Bulletin 75 just issued by the Bureau of Mines. This is a volume of over 300 pages containing "Rules and Regulations for Metal Mines," with the purpose of securing greater safety of operation, compiled by W. R. Ingalls, James Douglas, J. R. Finlay, J. Parke Channing and John Hays Hammond. It gives detailed and tabulated statistics of mine casualties, discusses their causes and formulates a complete code of rules for the conducting of mining operations and the manipulation and control of all the apparatus and agencies employed so that accidents may be most completely minimized or abolished. There is but one requirement noted concerning compressed air, which is that all air receivers shall be submitted to a pressure test 50 per cent. above the maximum pressure to be carried, and that they shall be regularly drained or blown off. The index of the book contains 52 page number references to the requirements regarding electrical equipment.

REPORT OF TESTS AT PLAINFIELD, N. J.

Number of well	3	4	5	6	8	9	10	11
Depth, feet	350	400	350	300	304	350	350	350
Length of discharge (100%)	204	204	203	204	210	217	205	213
Starting pressure, lbs.	66	60	60	65	65	65	65	65
Running pressure, lbs.	59	55	55	57	56	60	54	55
Shut in pressure, lbs.	53	51	50	54	51	54	48	50
Submergence, per cent.	60	57.5	56.5	61	56	57	53.5	54
Submergence, feet	122	117	115	124	117	124	110	115
Lift, feet	82	87	88	80	93	93	95	98
Free air constant	.400	.432	.440	.387	.462	.447	.485	.489

Average submergence	118
Average percentage of submergence	57
Average lift, feet	89.5
Average constant	.443

GENERAL AIR LIFT DATA.

Time, A. M.	10:05	10:20	10:35	10:50	11:05
Compressor, r. p. m.	67	67	67	67	65
Working pressure	69	69	69	69	68
Water lift reservoir, ins.	30⅝	31⅝	30	33⅞	32¼
Steam pressure	115	109	114	114	104

Average revolution of compressor per minute	66.6
Average working pressure	68.8
Revolution of pump in one hour	1818
Size of duplex pump cylinders	20½ x 24-inch stroke
Gallons per revolution	137.2
Gallons pumped in one hour	249,429.6
Gallons pumped per minute (displacement)	4157.1
Estimate slippage, 10 per cent.	415
Actual gallons pumped per minute	3742
Size of reservoir	250 x 22 feet
Gallons in reservoir per inch	2437.5
Loss in reservoir in one hour	1⅝ inches
Loss in reservoir in gallons	5586.5
Loss in reservoir per minute	93.1
Actual gallons pumped per minute	3649

AUTOMATIC PNEUMATIC APPARATUS FOR TRANSFERRING LIQUIDS

The following interesting description of an ingenious and practically successful device we reproduce, somewhat abridged, from Metallurgical and Chemical Engineering, Dec. 1, 1915.

In making use of compressed air power for handling liquids, it is necessary to have a blow-case or air-tight chamber into which the liquid is admitted (usually by gravity), and from which it is forced to its destination by the compressed air, the latter being also admitted to the blow-case at necessary intervals. The process consists, therefore, in admitting liquid until the blow-case is filled, then turning off the liquid and turning on an air valve which admits the air. This operation is repeated continuously as long as liquid is to be lifted.

THE AUTOMATIC FEATURE.

It has long been the effort of inventors to obtain an automatic device which will turn on and off the valves necessary for this operation, and a number of apparatus have from time to time appeared which have been claimed to accomplish this purpose. The chief objection, however, to these apparatus has always been their complicated construction, allowing too great an opportunity for trouble in the mechanical operation.

The latest of these devices, known as the Bihn-Jones automatic air device, seems to have overcome all these objections and is very simple in construction and operation. The apparatus consists of two parts. The first is an any-position check valve which is composed of two essential parts, namely, a body which contains the valve seat and a flapper which swings on trunnions, thus constituting a valve which will operate in any position. The second piece of apparatus is the automatic air device proper. It is composed, first, of a body in which is formed the seat of the valve, through which the ports for the admission of compressed air open, the upper portion of the body also containing the exhaust port. Secondly, a disk of a cone and piston type is provided which has two seats, at the bottom a cone which closes the compressed-air ports and at the top a flat seat which closes the exhaust port. These devices are illustrated in Figs. 1 and 2 respectively.

DETAILED ACTION OF DEVICE.

Parts of Air Device.—The air device consists of the following parts:

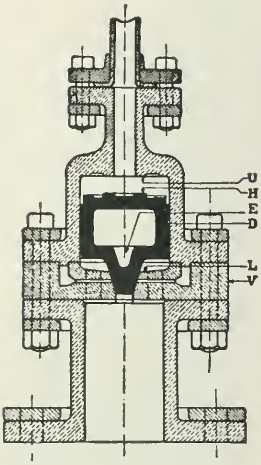


FIG. 1.

1. Valve body *V*, which contains a seat *L* controlling the ports for the admission of compressed air, and a seat *U* for controlling the exhaust ports.

2. Disk *D*, of the cone and piston type, the cone *E* being at the base and completes the compressed-air valve. At the top of the Disk *D* is a seat *H*, which completes the exhaust-air valve.

The device is actuated by the liquid from storage tank *A*, which flows through the check

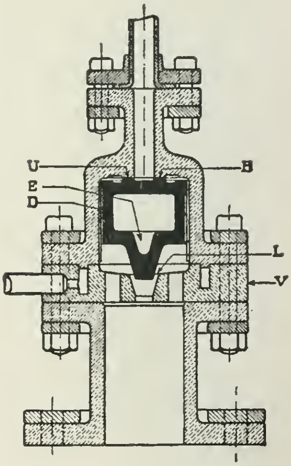


FIG. 2.

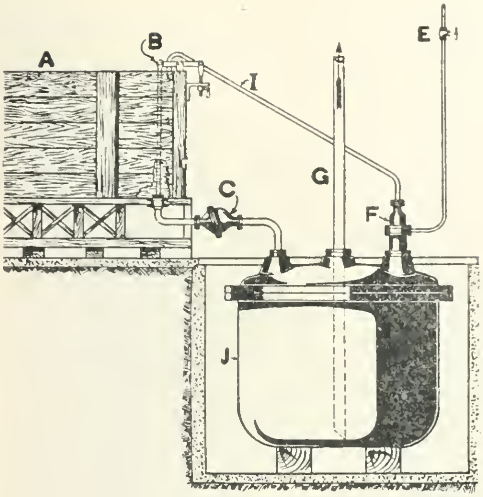


FIG. 3.

valve *C* into the blow-case *J*. This liquid rises until it reaches the cone of the disk *D* of the automatic-air device *F*, which it raises, thus permitting compressed air to enter.

The sudden release of the compressed air forces the disk *D* upward against its upper seat *U*, thus closing the exhaust port to vent pipe *I*.

The air pressure is thus prevented from escaping and the pressure exerted on top of the liquid closes the check valve *C* and forces the liquid through discharge pipe *G* to its destination.

When the level of the liquid reaches the opening of the discharge pipe at bottom of blow-case, the compressed air rushes out with the liquid, thus clearing the discharge pipe. The result of the air rushing out the discharge pipe causes a considerable drop of pressure within the blow-case, thus allowing the disk *D* of the air device to drop to its lower seat *L* due to its own weight, simultaneously cutting off the supply of compressed air and opening the exhaust port.

The check valve *C* in the supply line has remained closed during the emptying of the blow-case, but immediately upon the reduction of pressure within the blow-case the check valve opens (due to the head of the liquid in the supply line) and allows the blow-case to refill.

The free air or gas from liquid displaced from blow-case due to refilling is discharged to atmosphere through vent *I*.

The flow of liquid from tank to blow-case may be regulated by a plunger and thumb screw arrangement, as shown at *B* in Fig. 3, or by means of a stop valve. Accordingly, by regulating the supply, the contents of blow-case may be automatically discharged in any specified time.

It will be noticed from the above illustration that the apparatus is entirely outside of the blow-case, no part of it extending within the same, but resting upon a flange collar above the case. It can therefore be readily removed for examination, and its ease of operation may be readily understood.

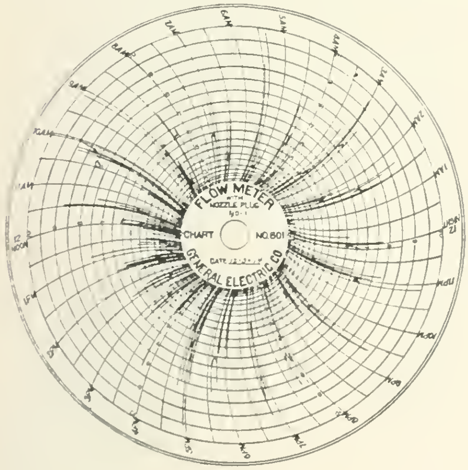


FIG. 4.

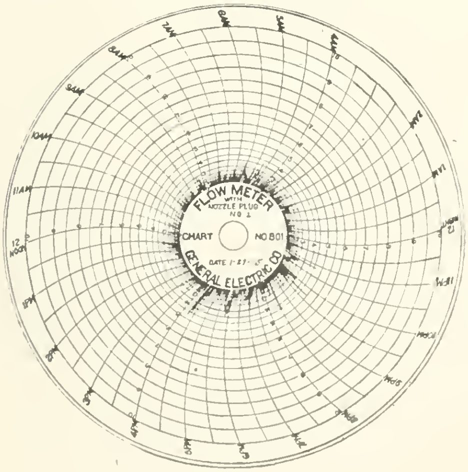


FIG. 5.

THE SAVING OF AIR AND POWER.

Aside from being entirely automatic in operation and simple in construction, this device is claimed to reduce considerably the consumption of compressed air which is known to be quite expensive. The charts, Fig. 4 and Fig. 5, were made in a plant where forty blow-cases are in use, seven of which were equipped with the Bihn-Jones automatic air device at the time the test was made. The heavy irregular lines indicate the exact travel of the needle, which indicate the comparative consumption of compressed air. Fig. 4 was produced when the blow-cases were operated by hand, that is, compressed air turned on and off each time the blow-case was discharged, while Fig. 5 illustrates the consumption of air by the seven blow-cases which were equipped with the Bihn-Jones device.

The saving in compressed air is further illustrated by the fact that in the above-mentioned case, in which the forty blow-cases, of 3 to 5½ tons capacity, are being filled and discharged continuously day and night, after the installation of the seven Bihn-Jones automatic air devices one of the compressors was shut down and has since been kept as a reserve unit.

This device is claimed to be particularly adaptable to conditions wherein large bulks of liquids are to be handled, and by properly selecting the material from which it is made it will handle with equal efficiency corrosive material, oily liquids, and, in fact, any material which may be readily caused to flow by compressed air. Its most extensive application is found in handling of sulphuric acid in fertilizer and acid manufacturing plants.

The device is being manufactured by The Schutte & Koerting Company of Philadelphia, Pa.

AIR PRESSURE FOR AUTOMOBILE TIRES

In a paper before the Society of Automobile Engineers, Mr. P. W. Litchfield, factory manager of the Goodyear Tire and Rubber Company, estimated the annual cost of tires in this country at $192,000,000 and further showed that at least 30 per cent of this, or $57,600,000, is wasted by improper loading and inadequate inflation. The following self-explanatory table of pressures and permissible loads per tire was presented.

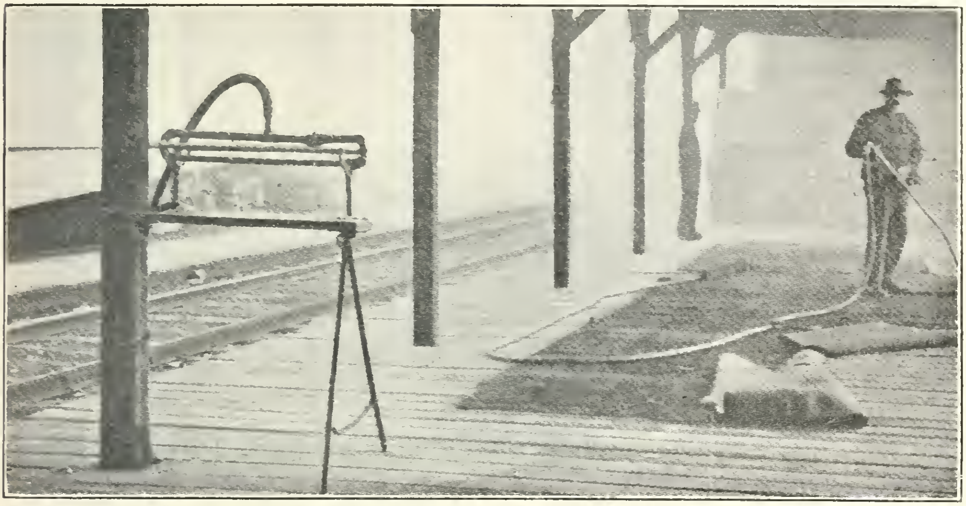
Long experience has shown, says Mr. Litchfield, that these loads and air pressures are the most satisfactory combination for maximum service and effective cushioning. The qualities of comfort and easy riding must be recognized as vital points, equally as important as tire durability. Why are pneumatic tires used at all if not for easy riding?

GROSS LOAD, POUNDS PER TIRE, INCLUDING PASSENGERS AND COMPLETE EQUIPMENT

Inflation Pressure, Lbs.	Tire Section Diameter						
	3 in.	3½ in.	4 in.	4½ in.	5 in.	5½ in.	6 in.
30	250						
35	290	360					
40	335	410	500				
45	375	460	560	675			
50	415	515	625	750	875	1000	1140
55	460	565	690	825	960	1100	1255
60	500	615	750	900	1050	1200	1370
65		670	815	975	1135	1300	1480
70		720	875	1050	1225	1400	1595
75			940	1125	1310	1500	1710
80			1000	1200	1400	1600	1925
85				1275	1485	1700	1940
90				1350	1570	1800	2050
95					1660	1900	2165
100						2000	2280

The degree to which a tire is flattened against the ground varies with the load. For every given tire load there is a definite percentage of tire deflection which bears a direct relation to the inflation pressure. Obviously, then, a scale of relative carrying capacities and inflation pressures, if properly observed, will tend to eliminate the enormous waste now caused by haphazard methods of loading and inflating.

The load properly assigned to a tire should be the actual load on the tire with the car fully loaded. The actual load on each tire can be ascertained by weighing first the front of the fully loaded car, then the rear, dividing each figure by 2 to get the load per tire. It can then be inflated to the proper pressure for that particular weight as indicated by the scale of carrying capacities and inflation pressure. A certain tolerance in pressure should be allowed for leakage, but before the pressure drops 20 per cent the tire should be pumped up again.



CLEANING CARPETS AT RAILROAD TERMINALS

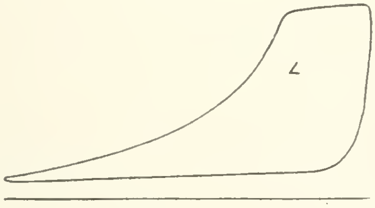
The method of cleaning carpets at the car yards of the Chicago & Western Indiana, a terminal company at Chicago, is shown in the illustration. Compressed air is used. The arrangement shown at the left is for cleaning or blowing the dirt out of the aisle strips. It consists of two guide rods and a pipe with perforations on its under side. The carpet is passed over one guide rod, under the perforated pipe and out over the other guide rod. The arrangement is simple and cleans the aisle strips thoroughly. The method of cleaning the larger pieces of carpet is shown at the right. Air from the shop line is used in both cases, the water being thoroughly blown out of the apparatus and pipes before using.—*Railway Age Gazette.*

DISCHARGE VALVE TROUBLE IN AMMONIA COMPRESSOR

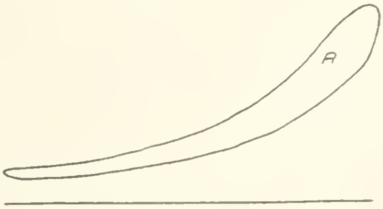
The cut here reproduced from *Practical Engineer* shows two indicator cards from an Ammonia Compressor which tell a very clear story. An ice plant which had been running several years was producing less refrigeration than usual, showing that something was wrong. The trouble was thought to be in the compressor, which had duplex, single acting compressor cylinders, as one ran warmer than the other, although the same amount of cooling water was used on each.

Diagram No. 1 was taken from the left hand cylinder, and as this was thought to be fairly good, No. 2 was taken from the right hand cylinder. This showed at once that this cylinder was doing very little work, and that the trouble was principally with the discharge valves.

The machine could not be spared very long



N° 1



N° 2

at a time, writes Mr. J. C. Hawkins, and we decided to examine the springs and discharge valves on the defective side. After getting the cylinder open, we found one valve spring broken, and all the discharge valves were badly gummed up with a putty-like substance of grease and scale. The valves and springs were washed with coal oil, and a new spring put in place of the broken one. After the machine was started, the indicator was applied again and a diagram similar to No. 1 taken.

From the conditions found in this cylinder it was decided to open the other compressor at the first opportunity, for the purpose of examination, and cleaning out the valves. After overhauling the machine the output of ice was increased to its regular amount.

If the machine is to do good work, the discharge valves must be examined occasionally, as a slight leakage back through the valves will greatly decrease the output of the compressor. The spongy substance in the cylinders was thought to have been due to the use of a poor grade of ammonia oil in the compressor, which was being used at that time on account of its low price. Changing to another grade of oil helped to prevent further trouble from valves sticking.

NEW LIQUID AIR BLASTING PROCESS*

The first equipment with liquid air as an explosive dates back nearly to the beginning of its industrial production. Professor von Linde made an explosive called "Oxyliquit" by mixing liquid air with charcoal. This explosive broth, or paste, was put directly into the drill hole and fired by means of cartridges and fuses.

Since this primitive method gave unsatisfactory results, it was modified by filling a suitably prepared cardboard cylinder with an explosive substance, preferably by dipping the whole in liquid air. This method gave results, but was lacking in safety and depended on the skill of the workmen and quickness of manipulation. The trouble was due largely to the enormous difference in temperature between the liquid air and the surrounding rock, so that the air rapidly evaporated in the hole. The maximum theoretical life of a blasting cartridge was thus only 10 min., while in practice it was still shorter.

Interesting experiments have been made in France by Georges Claude, and other experiments which improve upon the von Linde method have been conducted in Charlottenburg, Germany, by Kowatsch, with the coöperation of von Baldus.

In order to prevent a rapid evaporation of the liquid air, Kowatsch puts the cartridge with the dry carbon container in the drill hole before introducing the liquid air and avoids the dangerous loss of time by necessary preparations, such as tamping the hole after the mixture has been made. The liquid air is not introduced until time for shotfiring. This reduces the evaporation period to a minimum.

The cardboard cylinder contains a perforated partition tube in which is placed a perfectly innocuous mixture of infusorial earth and oil or asphalt, or of soot and paraffin. The central partition tube incloses a cardboard tube, over which is thrust another cardboard tube to serve for carrying off the evaporation product of the liquid air. If several holes are to be fired at once, the electric wires are connected.

The liquid air intended for each hole is provided in a suitable quantity in a small flask to the opening of which is attached a metal tube with a conical point, into which tube is introduced the central tube of the cartridge. To charge the cartridge, it suffices to raise the back end of the flask. The liquid air is then lifted by pressure of its evaporation products (just as water containing gas is lifted by pressure of carbonic acid) in the metal tube and is forced into the cartridge. At the moment when the shot is fired by an electric fuse, the liquid air combines with the components of the charge and causes an explosion of extraordinary energy.

The volume of the saline matter in the ocean is somewhat more than 265,956,133,600,000 cu. ft., according to the United States Geological Survey, or enough to cover the entire surface of the United States, excluding Alaska, 8,448 ft. deep, or more than a mile and a half.

---

*From an article by M. Pryzborski, mining inspector, Budapest, Hungary, in the *Montanistische Rundschau.*

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton. Pa., Post Office.

Vol. XXI. JANUARY, 1916. No. 1

CONTENTS

Bypass Around Leaky Tunnel.......... 7843
Lining a Tunnel by Compressed Air... 7847
Deep Diving Record 7848
War Consumption of Metals.......... 7848
Dynamite Ditch Digging.............. 7848
Edison Wireless Telegraphy........... 7849
Air Tests the Fineness of Cement..... 7850
Lifting Water by Compressed Air.... 7850
Safety of Compressed Air in Mining.... 7858
Pneumatic Transfer of Liquids........ 7860
Air Pressure for Automobile Tires.... 7862
Cleaning Carpets for Railroads........ 7863
Valve Trouble in Ammonia Compressor. 7863
New Liquid Air Blasting Process..... 7864
New Year Optimism 7865
Freezing of Air Pipes in Winter....... 7866
Compressed Air Tunnel Ventilation.... 7867
Handling Drill Steel 7868
Lung Motors 7869
Notes 7869
Patents 7871

NEW YEAR OPTIMISM

The final page is filled, the book is closed
Which holds the record of the buried year;
And such a year may earth ne'er see again,
As surely never was the like before,
What times are these in which we find ourselves,
Or who had dared to prophecy of what
So suddenly has come upon us?
Cajoled by soothing sophistries, we thought
And talked of peace as though nought else could be.
Of comfortable toil and honest gain
We had our wonted schemes, and while we wrought
There burst a storm unparalleled and full
Of crashing devastation, death and woe.
It seems that all the arts so full of good,
Which made this later age so rich and fat,
Can still be used as well for purposes
Most devilish. So while we piled our gains,
And gloried in the increase of our wealth,
Grim war was learning also of new ways
To kill, was stacking up his projectiles.
His ammunition and his guns of strength
To strike afar.

Most curious it is
That agencies beneficent, and rich
In most desired accomplishment, are just
The things which make the pungency of war,
The high explosives rend the rocks and cut
The channels which convey from mountain lake
To thirsty city health and strength, or spread
The waters over sun-parched plains, and make
The wilderness to yield us grain and fruit.
These giant helpers pierce the hills and make
The paths of trade and pleasure smooth and straight,
And distance is forgot. They make the deeper rocks
To yield us coal and iron, metallic stores
For varied industry, and gold which men
Do strive for evermore.

Now so it is
That strength Herculean is none the less
When turned to tasks sinister. Modern war
Had never been but for what peace has taught,
And only by the means which peace provides.
Success could e'er be thought of. Fighting now

May be on land or sea, or in the sky,
Or in dark waters 'neath the wave and none
Is satisfied or safe to fight without
Explosives of the sharpest. Armed with these
Commensurate accomplishment is sure
As in the ways of peace.

But after all
A great automaton, too great, too slow,
For individual human kin to scan,
Is this old world of ours. She has a way
To set things right, so right that all shall see
And know them to be better than before,
The ways of prosperous peace may sometimes need
Correction, but for war the end is sure.
The winning one is peace, the loser war;
No constant loser can keep up the game,
And when the stakes are gone it must take long
To get the means and will to play again.
And so we live in certainty of peace
For long enduring years when this great storm
Has spent its force. Preparedness is well,
But first, and without haste, we have to find
What 'tis we must prepare for. R.

THE FREEZING OF AIR PIPES IN WINTER

BY FRANK RICHARDS.

The following inquiry recently received should be of interest to others besides the writer:

"I have air traveling through a 4-in. pipe on the surface of the ground about 2000 ft. and I expect to work this winter. How can I prevent the air from freezing? Will glycerin dropped into the pipe, say ½ pt. per day, prevent it from freezing? Shall I cover it with box and manure? At what temperature is it likely to freeze? How much circulation must air have to prevent freezing?"

This is an interesting series of questions and all to the point, also pertinent to the approaching season. In replying, it should first be remarked that, as our correspondent of course knows, it is not the air that freezes and makes the trouble, but the water which the air carries, and not all of that. Atmospheric air normally always contains intimately distributed through it, a variable proportion of water, and the ability to carry more and more, or to hold more securely what it already contains, comes with increase of temperature. When air is compressed with little or no cooling during the compressing operation, as it generally is even if the cylinders are water-jacketed, it is delivered at a considerably increased temperature, and so long as the heated condition continues there can be no deposition of water, which is why water is not deposited in an air receiver located near the compressor.

As the air flows along through a pipe line, however, it cools very rapidly, and in a run of 2000 ft., as above, it would certainly be cooled nearly to the temperature of its surroundings. If the air has been compressed to a pressure of, say, 6 atmospheres, or 75 lb. gage pressure, its capacity for moisture is reduced, for corresponding temperatures, to about ⅙ of that of the free air, with which it started; consequently, as it has flowed along through the pipe and has gradually cooled, it has been giving up its moisture to collect and flow along the bottom of the pipe.

Now, if it happened to be freezing weather and the pipe was cooled to below the freezing point, the water thus flowing within it would certainly freeze there, and keep on freezing layer upon layer, until the pipe might be completely choked by the accumulated ice. The only thing to do under these conditions is to protect the pipe so that its contents will not freeze. This, of course, may be done by covering it with sufficient protective material or by burying it in the ground to a sufficient depth, the same as a water pipe. Means should be provided for drawing off the water at low points; if there were alternating periods of freezing and thawing, the latter should be taken advantage of for draining, although the thawing would probably be slow after the ice was once formed.

It is good practice, and it will pay for itself in most cases, to provide an efficient after-cooler near the compressor, and in connection with that a separtor to take care of the water; any good steam separator would do, and the latter, taking the air when it was at its highest pressure and at its lowest temperature, both conditions minimizing the capacity of the air for moisture, should leave little or no water to be carried along into the pipe line.

As to how much circulation the air must have to prevent freezing; this would have little to do with it, and the greater the volume of air the greater also would be the quantity of water carried by it and ready to be deposited and frozen if the other conditions concurred.—*Practical Engineer.*

THE FIRST COMPRESSED AIR TUNNEL VENTILATION

BY F. M. PIERCE.

In the mammoth workings of the famous Comstock Lode, at Virginia City, Nev., were initiated many of the practices that have been developel into systems. The nature of the rock in that locality and the great depth of the workings generated extreme temperatures when the rock was exposed to the air. This made it necessary to introduce quickly into the faces of the extreme workings fresh, cold air in sufficient volume to sustain the almost naked and sweat-smothered miners working in short shifts or reliefs.

Power rock drills driven by compressed air were first extensively used in mining and tunneling in the Comstock Lode. True, such machines had been employed in the Hoosac Tunnel in Massachusetts and in another driven in Pennsylvania, but they were so heavy and cumbersome, requiring ponderous carriages for their mounting, and mechanically were so defective that as economical factors in tunneling they had given little if any advantage over hand drilling. Later they were modified and made more adaptable, and their practical worth was first demonstrated in the Sutro Tunnel driven to tap the Comstock Lode at depth to drain it of water and permit transportation of the ores to the mills near the tunnel's mouth.

Smaller machine drills adapted to the mine drifts came to be quite generally used in the workings of that lode, and the compressed air with which they were driven, exhausting from them into the extreme headings and expanding to four or five times its volume and thus being rendered very cold, supplied the miners with ample fresh, cold air and a ready and admirable means of ventilating the workings.

From this Comstock Lode practice has developed the system of tunnel ventilation by compressed air now generally employed. But its growth was slow and round-about. In fact the resumption of this local practice with compressed air and its development in large tunnel work were taken up many years later, after steam exhausted from power drills had proved to be more or less a success in such work.

Steam-exhaust ventilation was first demonstrated by a Colorado miner whose name I do not recall. With one power drill driven by steam, he ran a small mine tunnel 1,000 ft. into a mountain and ventilated it by utilizing the exhaust steam from his machine in the following manner:

Near his steam boiler, at the mouth of the tunnel, he set up a wooden box chimney connected at the bottom to a similar horizontal box which ran in near the face of the heading. Into the end of this flue he set up a wide-mouthed funnel, which was removed before blasting. By opening a ¼-in. steam jet in the chimney after a blast, he caused a strong suction to draw the foul air into the inner end of his ventilating box. This in no long time so cleared the extreme heading that he went in, set up his funnel and machine and went to drilling, carrying the exhaust steam through a hose into the funnel. The exhaust was sufficient to maintain the draft, and the live-steam jet in the chimney was shut off. This device kept his tunnel filled with a flow of fresh air and his heading comfortably cool. This worthy adventurer took righteous pleasure in writing me of his success with steam against my expressed belief that he could not make it work successfully in tunneling.

Years later, on one of the several railway tunnels that were undertaken on the South Penn Ry. to run between Harrisburg and Pittsburgh, the contractors started using steam for driving the drills until air compressors could be built and installed. On getting in a distance, the steam from the machines uncomfortably raised the temperature. The Colorado miner's device recurred to my mind, and it was introduced, where some seven drills were in operation. It ventilated the tunnel while it was being driven in some 800 ft.

Years after the South Penn work the Croton Aqueduct Tunnel for the supply of water to New York City was under way. This 36 mile tunnel was the longest that had ever been undertaken. In the center of every 3,000 ft. section a shaft was sunk to grade, and tunnels were driven north and south from this, each 1,500 ft., until they met opposite headings. Extensive ventilation was unnecessary, and this was foreseen to be very expensive unless some method other than by the usual exhaust fans or blowers could be devised.

I had equipped half of the tunnel, under contract with Brown, Howard & Co., with Ingersoll drills, air compressors, boilers, etc., and was in constant consultation with D. D. McBean, of that firm, the manager of the work. When the matter of ventilation came up, Mr. McBean was in no way disposed to go into the large expense of equipment with known appliances if this could be obviated—and he was not the man to permit difficulties of any nature to prevent the employment of simple and effective means. On his hearing of the success of compressed air in the Comstock heading and steam exhaust in the Colorado mine and the South Penn Ry. tunnel, he decided to try them in his work on the Croton Aqueduct Tunnel. They were successfully adapted. This was the first development and use of the since well-known system of compressed air ventilation for large tunneling operations. The features of this system and its details have become too well known to warrant mention here.

Up to that time, as president of the Ingersoll Rock Drill Co., I had furnished the mechanical equipment for seven-eighths of the railway and other large tunnels that had been made using power drills, and was therefore in a position to know what appliances had been tried or used. To the best of my knowledge this is the history of the rise and development of this system of tunnel ventilation. —*Engineering News.*

HANDLING DRILL-STEEL

BY P. B. MCDONALD.

The old method of handling drill-steel at a mine, namely, getting the dull steel to the sharpening-shop on surface and the sharp steel to the miners underground, was careless. As little attention as possible was spared for this purpose. In some cases, each miner carried his dull steel to the shaft when he went up at half-shift, took the bundle up on the cage, and carried it to the blacksmith-shop; the sharpened steel he carried back in the same manner.

There are many objections to this primitive method:

1. A miner should have as many miscellaneous worries removed from his shoulders as possible; his job is to mine, and he has enough to do if he does that well.

2. It is dangerous for men to crowd into a cage when each has an armful of drills to carry; a stray drill sticking into the shaft may wreck the cage.

3. If the shop is quite a distance from the shaft, as it frequently is, the task of carrying a dozen lengths of drill-steel there, perhaps through snow or rain, is exhausting to a man in wet or thin underground clothes.

4. When a miner has to carry his own steel, he will continue to use dull drills as long as possible rather than change, thus working with poor tools.

Another method of collecting and distributing steel is to have one or more 'drill-boys' make the rounds of the mine, hoisting and lowering the steel without danger of accidents, in much the same manner as 'powder-mongers' distribute explosives underground. There is not so much objection, however, to the miners carrying dull steel to the shaft underground and sharp steel from the shaft to their places of working, so long as that is the limit, because they have to walk in and out to these places anyway. Where the mine has but a one-compartment shaft, it is a good plan to utilize the lunch-hour or any periods of time between shifts to have the drill-steel raised and lowered.

Among the aids to the handling of drill-steel in use at large mines are the following. Wooden racks, either horizontal or vertical, are built on each level near the shaft, where sharp steel is kept always on hand arranged in the different racks according to lengths; then, whenever any miner wants sharp steel he merely carries out his dull drills to the shaft-station and takes back sharp sets; the racks are kept full and the dull steel is taken to surface by a special man or two. To convey the steel between the shaft and the sharpening-shop, horses and wagons can be employed advantageously; one mine has a special wagon-box which is removed at the shop by a traveling-crane and lifted handily to the drill-sharpeners. Another aid to good work by the miners is to keep each contract's or gang's steel separate. Numbers corresponding with the contract are stamped on the shank of each drill, and when sharpened each contract's drills are packed neatly in a 5-inch iron ring and held there securely with wooden wedges. Miners work to better advantage when they have individual steels.

The practice of constructing a tunnel from just below the collar of the shaft to the sharpening-shop is to be commended. Such tunnels have a narrow-gauge track and push-car, and are lighted by electricity. By the use of them, drill-steel can be unloaded from the cage onto the push-car without distributing operations around the surface of the shaft, which is always a busy place.

Recent improvements in mechanical drill-sharpeners and drill-makers, and the use of special dies for forming new-style bits, such as the Carr, have tended to systematize and improve the sharpening of drill-steel. The assiduous application of the principles of scientific management has indicated the immense importance of properly-designed and correctly-sharpened bits. Drill-steel and bits are seemingly trivial but actually are extremely significant matters. It is the drill-bit that is the critical link between the men and the rock to be removed.—*Mining Press.*

LUNG MOTORS

A new device for the saving of lives in the coal fields of Pennsylvania are the lung motors which are used for the same purposes as the pulmotors of the many trained rescue squads. The lung motors are now in successful use for the resuscitation of victims of drowning, asphyxiation and electric shock, all possibilities in the complex internal economy of a modern mine.

Wherever the natural breathing of the victime of an accident has been arrested, the lung motors have proved invaluable. They weigh about a third as much as a pulmotor and have the advantage that they can be operated by one man. In construction they resemble a bicycle hand pump, but there are check valves on the intake and exhaust. A mask lined with a rubber cushion that can be inflated so as to cut off all outside air when held firmly against the face, is placed over the nose of the victim, and there are instructions on the apparatus itself as to how many strokes a minute to make for victims of different ages from childhood to maternity. The number for an adult is eighteen.

By a mechanical device attached to the foot of the pump the lung motor can be arranged so as to give the victims nothing but air, half air and half oxygen, or all oxygen. When the latter is necessary the oxygen tank from one of the Draeger oxygen helmets with which all rescue squads are equipped can be used.

TOO MUCH FUNNY BUSINESS

The following bulletin recently printed by the Youngstown Sheet and Tube Company fully explains itself:

"We have just had a man badly hurt while engaged in a 'kidding' match. This is not the first instance of the kind that has happened in our works. Wrestling, suffling, horse play, kidding and goosing have no place in any working establishment. Things may be started in all innocence and without intent to cause harm, but too often there is some unforeseen happening that results in a serious or perhaps fatal accident to one or several employees. Cut out the kidding game."

NOTES

Altitude does not affect men wearing mine-rescue apparatus. Four different types were tried at the top of Pikes Peak, Colorado, a height of 14,147 ft., by the U. S. Bureau of Mines at the end of August.

Hard hats should be worn by men working in shafts. At the Woodbury shaft of the Newport mine, Ironwood, Michigan, the miners were supplied with a hat made of felt treated with rosin and shellac. Such hats are hard enough to resist a severe blow.

"Blackboards" made of plate glass have been installed in the classrooms of a Portland, Oregon, school. The writing surface is prepared by a special sand-blast treatment and the back is painted black. It can be readily wiped or washed and is easily kept fresh and clean.

Australian miners are digging for gold in the trenches on Gallipoli Peninsula, says a dispatch to the Chicago *News.* They were surprised at the similarity of the Gallipoli ground to the Australian gold fields, and their sharp eyes soon discovered traces of the yellow metal. In their spare time the miners built rude placer outfits on the seashore and began washing for gold. They found it, and now the Australian troops with mining experience are passing every minute when not fighting the Turks in washing clay, which is brought to the shore from half a mile inland.

At a certain lumber camp in the northwest it was suggested that a lot of sanitary drinking cups be ordered. "Good idee," said the camp boss, "we'll git some o' thim kind o' cups right away, and while we're about it we'll git a gross o' medicine droppers so's the min kin use 'em to spit on their hands."

It is estimated that 200,000,000 lbs. of copper was required in the manufacture of 50,000,000 shells contracted for in this country since the war began up to October 1. It is also estimated that 94,000,000 lbs. of spelter will be consumed in this manufacture, as well as 346,000,000 lbs. of lead in the loading charge of these projectiles.

Pumping a man full of compressed air is still considered a joke by some people. Besides the case recently reported by the *Journal,* a worker at the Midvale Steel Works in Pennsylvania was subjected by two facetious fellow workmen, to an air hose containing air at a pressure of 80 lb. per sq. in. Immediate injury was not discovered, but soon after the man was suddenly taken ill while at work. At the hospital it was discovered that almost every internal organ had been ruptured by the air pressure, and it is not expected that the man can live. The fool-killer is a long way behind in his work.—*Eng. and Min. Journal.*

The B. F. Sturtevant Company has placed a portable electric warm-air blower on the market. It is offered for more or less temporary heating in a garage; for drying paint and also for drying in dyeing, photographic and blueprint rooms, and for heating rooms used only occasionally. The outfit consists of a small motor-driven fan discharging air through electric heating coils placed in an aluminum casing, the forced circulation being relied upon to give a very large volume of air in a short time. Five different sizes of sets are made and the air is delivered at one, two or three temperatures, depending upon the size. The fan outlet can be turned to discharge in any direction and the switch mounted on the base has different positions to control the temperature of the air delivered.

A remarkable record of continuity of service in power plant operation has been reported by the Quincy Market Cold Storage and Warehouse Company, at Boston. Mr. Fairbanks, the chief engineer of this company, reports that they have had in operation a 500-kilowatt Westinghouse-Parsons turbine that has been carrying load continuously for two years and eight months without the steam being turned off at the throttle. Recently they decided to shut down the turbine to give it an inspection, which showed that the machine was in good condition and it was immediately put back into service.

Secretary Lane in his annual report speaks of the necessity for a new set of mining laws. "The old code," he says, "is so elaborate and complicated that the best of brains can not tell what the law is. The truth seems to be that between mining engineers and mining lawyers the rules of the game have been refined into obscurity; and if Congress were to say to the President that he might select three men familiar with mining laws and miners' difficulties to suggest a new mining code to Congress, it would, I believe, be giving in earnest a new freedom to the mining industry."

The United States produces every mineral that is needed in industry, and this can be said of no other country. We produce 66 per cent. of the world's output of petroleum. 60 per cent. of its copper, 40 per cent. of its coal and iron, and 32 per cent. of its lead and zinc. Tin in small quantities is produced in Alaska and patinum in Oregon, Nevada, and California, manganese in Virginia, Georgia, Arkansas, and California; but of these latter minerals, as of nickel and some others of less importance, our supply is altogether inadequate for our consumption. We can build a battleship, or an automobile (excepting the tires), a railroad or a factory entirely from the products of American mines and forests.—*Annual Report of Secretary of the Interior.*

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 2.

1,158,525. FLUID-PRESSURE MOTOR. Edward W. Meredith, Reynoldsville, Pa.

1,158,621. FLUID MOTOR, PUMP, AND THE LIKE. Charles H. Birch, Chicago, Ill.

1,158,679. AIR-SUCTION VALVE. Harry P. Gray, Oakland, Cal.

1,158,738. ORGAN-BLOWER. Ira H. Spencer, West Hartford, Conn.

1,159,094. CENTRIFUGAL AIR-COMPRESSOR. Richard H. Rice, Lynn, Mass.

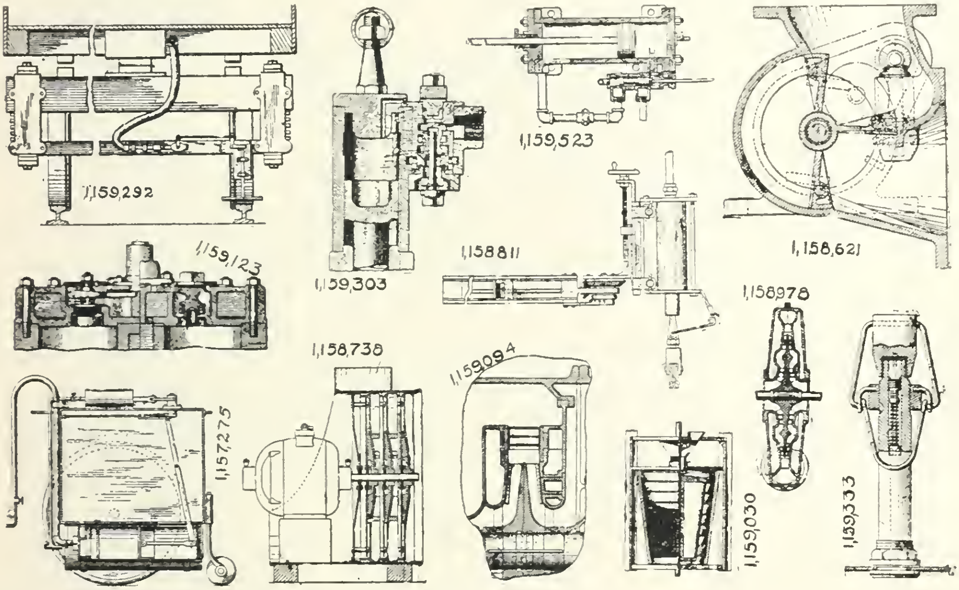
1,159,123. COMPRESSOR. George F. Steedman, St. Louis, Mo.

1,159,275. DISPENSING DEVICE. Arthur M. Roland, San Francisco, Cal.

1. A liquid receptacle comprising a tank, a pump connected therewith and supported by the tank below the same, an air tank, a pressure cylinder, a piston therein, pipe connections between the pressure cylinder and air tank to operate the piston, a lever within the tank, and connections between the lever, the pressure cylinder and pump to operate the latter.

1,159,292. EMERGENCY OPERATING DEVICE FOR AIR-BRAKES. Jeremiah H. Teuteberg and Philip E. Schafer, Baltimore, Md.

1,159,303. FLUID-ACTUATED MOTOR. Daniel S. Waugh, Denver, Colo.



Pneumatic Patents November 2.

1,158,811. STONE-CUTTING TOOL. Charles Kilburn, Cincinnati, Ohio.

2. In combination with a standard, of a tool beam pivoted thereon, a tool beam head on said tool beam, a plurality of pneumatic hammers on said tool beam head, means for oscillating said tool beam head as the tool beam is swung on its pivot.

1,158,843. PROCESS OF TREATING RUBBER AND RUBBER-LIKE MATERIALS. Raymond B. Price, New York, N. Y.

1. The method of treating vulcanizable plastics preparatory to their vulcanization which consists in incorporating a vulcanizing agent therewith and subjecting the mass during or subsequent to the incorporation of said agent, simultaneously to a kneading action and to the action of a vacuum.

1,158,978. TURBINE-PUMP, TURBINE-BLOWER, AND PROPELLER. Alfred Buchi, Winterthur, Switzerland.

1,159,030. PNEUMATIC SIFTER. Franz Holl, Worms-on-the-Rhine, Germany.

1. In a device of the character described, the combination of a fan including vanes of varying radius, a separating casing surrounding said fan, and means for feeding material through said casing, substantially as described.

1,159,333. AUTOMATIC VALVE AND HOSE COUPLING AND DUST-CAP FOR PNEUMATIC TIRES. Alfred Beliveau, Providence, R. I.

1,159,335. SEAL FOR VACCUM APPARATUS. Frederick G. Keyes, Boston, Mass.

NOVEMBER 9.

1,159,374. PNEUMATICALLY - OPERATED PIANO. Christian Gulbranson, Chicago, Ill.

1,159,406. OILING DEVICE. Mike Mintz, Rock Island, Ill.

1. In a device of the class described, the combination with a compressed air chamber, a release valve opening therefrom, a receptacle having its ends partially open, and tubes leading from the extremities of said receptacle to the original oil receptacle.

1,159,434. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,159,518. HYDROPNEUMATIC GAGING APPARATUS. Christ Maul, Chicago, Ill.

1,159,543. FLUID-BRAKE FOR BARREL-RECOIL GUNS. Friedrich Stock, Essen-on-the Ruhr, Germany, assignor to Fried. Krupp Aktiengesellschaft, Essen-on-the-Ruhr, Germany.

1,159,554. PUMP. Carl J. Veley and Lincoln S. Deal, Kalamazoo, Mich.

1,159,610-1-2-3. FLUID-MOTOR OR PUMP August Sundh, Hastings-upon-Hudson, N. Y.

1,159,627. PNEUMATIC - DESPATCH - TUBE SYSTEM. Alexander Watson, Beachmont, Mass.

1,159,721. MEANS FOR THE CONTROL OF THE FLOW OF AIR IN WATER-TANKS. George Sinclair, St. Paul, Minn.

1. Apparatus of the class set forth, comprising in combination, a receptacle adapted to contain a cooling liquid, means having orifices adapted to project compressed air into said cooling liquid and means for regulating the size of said orifices.

1,159,722. DRILL - SHARPENING APPARATUS. Arthur H. Skaer, Denver, Colo.

1,160,076. CENTRIFUGAL AIR OR GAS MOVING OR FORCING APPARATUS. William George Hay, Prestwich, England.

1,160,695. HUMIDIFYING AND HUMIDITY-REGULATING APPARATUS. Bruce L. Cushing and Edward W. Errick, Buffalo, N. Y.

1,160,786. VACUUM - CLEANER. Emil F. Swanson, Galesburg, Ill.

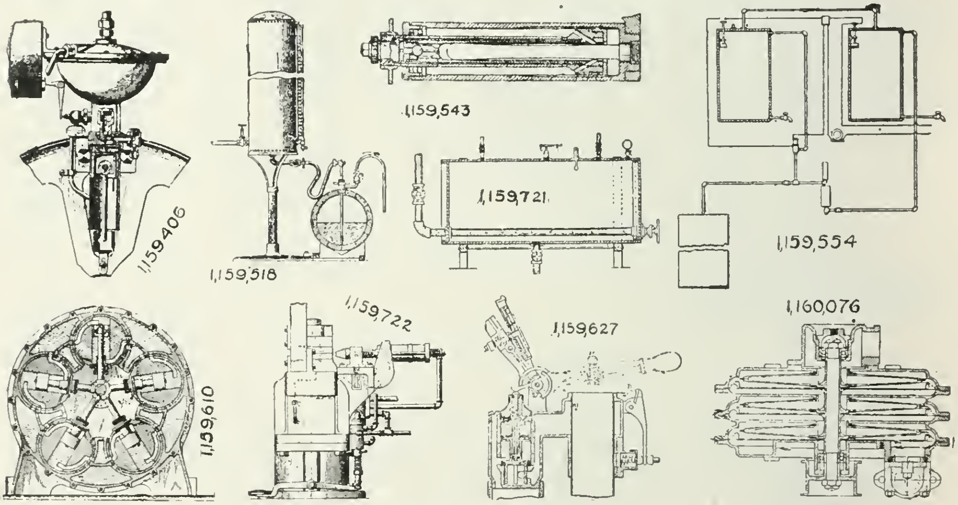
1,160,796. PNEUMATIC SHEET - FEEDING APPARATUS FOR PRINTING-MACHINES AND THE LIKE. Fred Waite, Otley, near Leeds, England.

1,160,800. ENGINEER'S BRAKE-VALVE. Peter Wertz, Pittsburgh, Pa.

1,160,801. EMERGENCY AND EQUALIZING VALVE FOR AIR-BRAKE SYSTEMS. Peter Wertz, Pittsburgh, Pa.

1,160,825. VACUUM STRIPPING APPARATUS. William Birchall, Whitworth, near Rochdale, England.

1,160,852. PNEUMATIC SANDER. Anthony S. Conti, Chicago, Ill.



Pneumatic Patents November 9.

NOVEMBER 16.

1,160,166. AIR PUMP OR COMPRESSOR. Harry W. Hancock, Charlotte, Mich.

1,160,207. VACUUM-PUMP. Charles N. Sowden, Soledad, Guantanamo, Cuba.

1,160,260. PNEUMATIC ACTION FOR INTERIOR PIANO-PLAYERS. Melville Clark, Chicago, Ill.

1,160,283. COMMINUTED - FUEL FEEDER. John F. Hay, Erie, Pa.

1,160,321. PNEUMATIC SPRING FOR VEHICLES. Walter L. Rice, Denver, Colo.

1,160,411. PRESSURE-PUMP. Russell Huff, Detroit, Mich.

1,160,426. ALTITUDE - GAGE. Coleman J. Manning, Medford, Mass.

1,160,528. AIR OR OTHER FLUID-PRESSURE PUMP. William Renard Pilkington, Bamber Bridge, near Preston, England.

1,160,562. GOVERNING MECHANISM FOR CENTRIFUGAL BLOWING-ENGINES. Otto Banner, Easton, Pa.

1,160,578. PNEUMATIC TOOL. John F. Clement, Philadelphia, Pa.

1,160,617. HANDLE AND INLET-CONTROLLING-VALVE CONSTRUCTION FOR PNEUMATIC TOOLS. Francis A. Jimerson, Athens, Pa.

1,160,922. CHANGE-SPEED MECHANISM FOR MOTOR-VEHICLES AND THE LIKE. John G. MacPherson, Philadelphia, Pa.

NOVEMBER 23.

1,161,102. PNEUMATIC SHOCK-ABSORBER. William G. Wood, Sacramento, Cal.

1,161,128. COMBINED ENGINE AND COMPRESSOR. Herbert T. Herr, Denver, Colo.

1,161,219. PROCESS OF AERATING WATER IN MAKING ICE. Willis B. Kirkpatrick, Baltimore, Md.

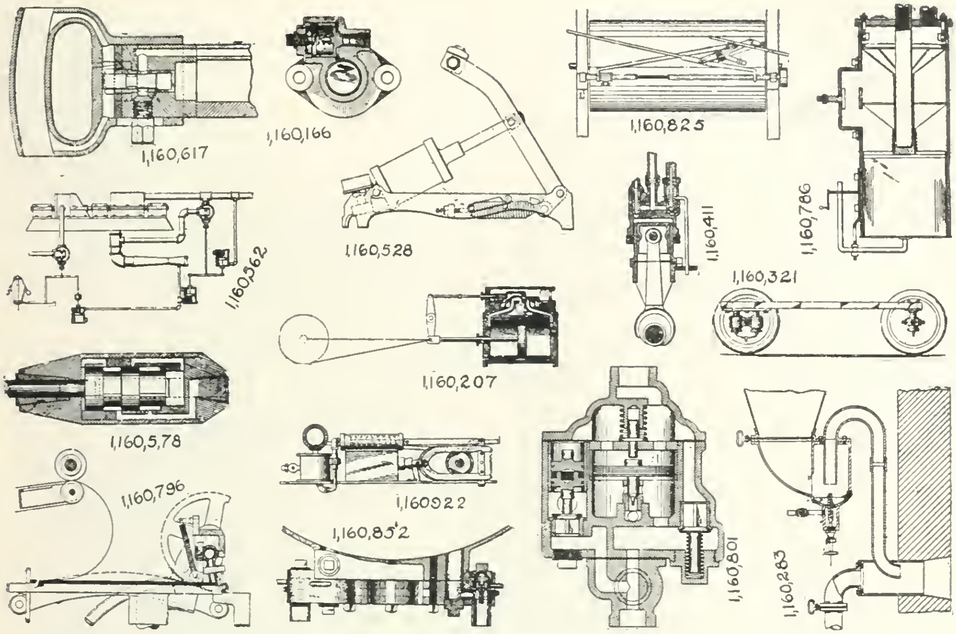
1. A process of agitating water by air in making ice which consists in compressing the air to a pressure in the vicinity of from twelve to twenty-five pounds above atmosphere, dehydrating the air by cooling it, reducing the pressure, passing such air through the mass of water to be frozen following a path near the center, and delivering air into the mass of water at the bottom.

1,161,259. DRILLING MACHINE. Mather W. Sherwood, Franklin, Pa.

1,161,263. CLEANING APPARATUS. Ira H. Spencer, West Hartford, Conn.

1,161,350. AIR-PURIFIER AND TEMPERATURE-REGULATOR. George Sinclair, St. Paul, Minn.

1. In an air purifier and temperature regulator, an air tank adapted to receive air under

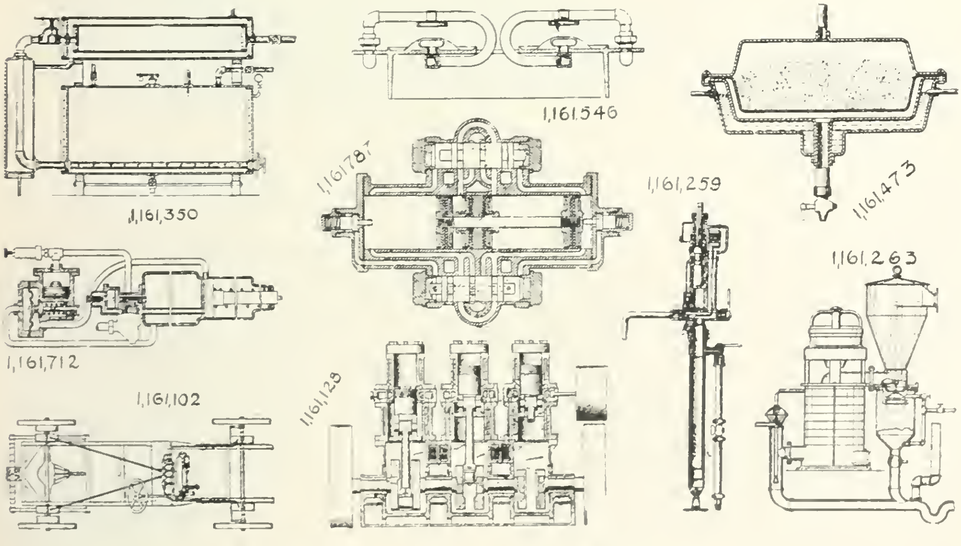


Pneumatic Patents November 16.

pressure, means for cooling compressed air in said tank, a water tank communicating therewith, a perforated pipe extending across the bottom of said water tank, a valve for automatically releasing the air in said compressing tank at a reduced pressure through said perforated pipe and into the water in said water tank to purify the same.

1,161,473. METHOD OF DRYING AND ENRICHING PHOSPHATE MATERIAL AND THE LIKE. Maximilian Mattheus Haff and Thomas Leopold Willson, Ottawa, Ontario, Canada.

3. The herein described method of drying and enriching a phosphate material which comprises placing the material in a closed container and



Pneumatic Patents November 23.

introducing ammonia gas and air under pressure.

1,161,546. HYDROCARBON-BURNER. James W. Stirton, Detroit, Mich.

1,161,712. AUTOMATIC RETAINING-VALVE FOR AIR-BRAKE SYSTEMS. Ernest U. Mack, Florence, S. C.

1,161,787. COMBINED MOTOR AND PUMP. Frederick C. Nickol, Dayton, Ohio.

1,161,789. CEMENT OR MORTAR MIXER AND ELEVATOR. Frank Orth, Indiana Harbor, Ind.

1. In a device of the class described, the combination of a conveying and mixing pipe, means for introducing dry materials into the front end of said pipe in desired proportions, means for creating a current of air throughout the length of the pipe for the purpose of carrying the dry materials along the pipe and mixing them together, means for heating said materials after they are mixed together and before they leave the pipe, and means for introducing water into the pipe and into contact with the materials after they are heated, substantially as described.

NOVEMBER 30.

1,161,907. POWER-HAMMER. Lewis E. Summers, Detroit, Mich.

1,161,917. FLUID-PRESSURE-REGULATING VALVE. Charles L. Bastian, Chicago, Ill.

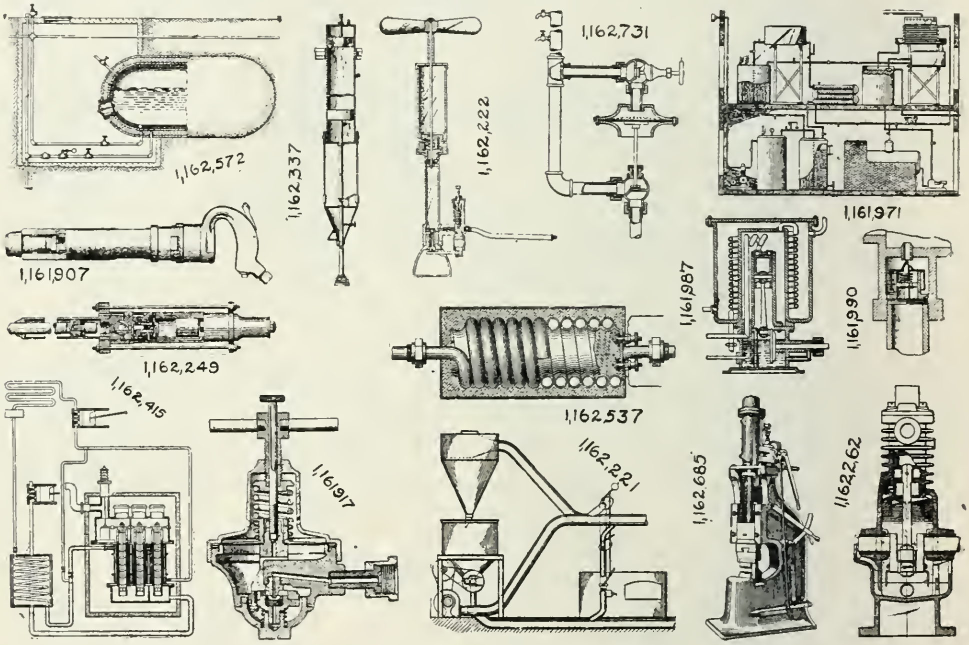
1,161,937. REFRIGERATING APPARATUS. Ludwig Horst, Hamburg, Germany.

1. In a refrigerating apparatus, the combination with the compressor, of a receptacle providing a condensing and a cooling chamber of large cross-sectional area, said condensing chamber communicating with the outlet from the compressor, means to direct a cooling medium through said cooling chamber, and an externally cooled condensing coil communicating with the condensing chamber.

1,161,971. APPARATUS FOR PURIFYING AND AERATING WATER. Joe F. Quigley, Oklahoma, Okla.

An apparatus for purifying and aerating water, including a boiler, a condenser, a steam pipe leading from the boiler to the condenser, a closed storage tank receiving the distilled water from the condenser, a compressed air tank, a washer receiving the air from the tank, an air cooling chest, a pipe leading from the washer to the air cooling chest, a heating coil surrounding a portion of the said pipe between the washer and cooling chest, a steam pipe establishing communication between the heating coil and the boiler, means for leading the air from the cooling chest to the storage tank and causing it to bubble upwardly through the water therein, and a check valve applied to the storage tank for permitting the escape of the air when an excessive pressure is reached.

1,161,990. COMBINED FLUID-PRESSURE REGULATOR AND SAFETY VALVE. Arther L. Smyly, Chicago, Ill.



Pneumatic Patents November 30.

1,162,221. POWDERED-FUEL FEEDER. Walter L. Caven, Cincinnati, Ohio.

1,162,222. AIR-PUMP. Leroy Clawson, Hall, Mont.

1,162,249. ROCK-DRILL. Vincent John O'Brien, Denver, Colo.

1,162,262. LUBRICATING APPARATUS FOR COMPRESSORS AND SIMILAR MACHINES. George F. Steedman, St. Louis, Mo.

1,162,337. GLASS-BLOWING MACHINE. Earl G. Chase, Smethport, Pa.

1,162,415. PROCESS OF AND APPARATUS FOR PRODUCING OZONE. Jan Steynis, Bay Shore, N. Y.

1,162,537. COMPRESSED-GAS HEATER. John Joseph Yager, Sheridian, Wyo.

1,162,572. COMPRESSED-AIR CISTERN. Wilbur T. Clark, Ashtabula, Ohio.

1,162,685. STONE-BREAKING MACHINE. Henry E. Derbyshire, Chambersburg, Pa.

1,162,731. VACUUM REDUCING-VALVE. William P. Burke, Springfield, Mass.

COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC.

1875

Vol. XXI FEBRUARY, 1916 No. 2

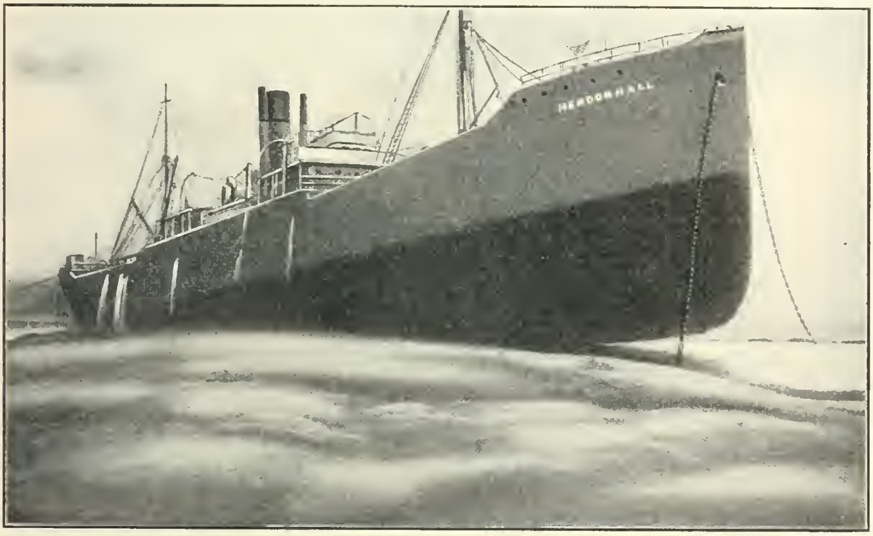


FIG. I. ON THE ROCKS—LOW TIDE.

THE REFLOATING OF THE HENDONHALL

This steamer owes its existence at the present time entirely to the good offices of compressed air. In November, 1914, she ran upon the rocks at high tide between Trinity Bay and Point des Monts in the lower St. Lawrence. The two half tones here given show her at high tide and at low tide, respectively. Large holes were torn through her bottom amidships so that the tide flowed freely in and out. Her condition for salvage was apparently so hopeless that nothing was done for seven or eight months.

About the middle of July, 1915, the Canadian Salvage Association, licensee of the Yankee Salvage Association, of New York City, took the job of getting the ship free so that she could be towed to Quebec. Mr. W. W. Wotherspoon, the well known wrecking expert, was in charge of the operations, and on August 26, nine months after she went ashore, the Hendonhall was refloated.

To enable the steamer to clear the rocks at high tide, its rise and fall being accurately known, it would be necessary to so lighten her as a whole that she would float at practically her "builder's light draft," or as she would be without freight, without coal, without water in either her boilers or the double bottom. Fortunately it happened that while the middle hold was open to the sea the ends

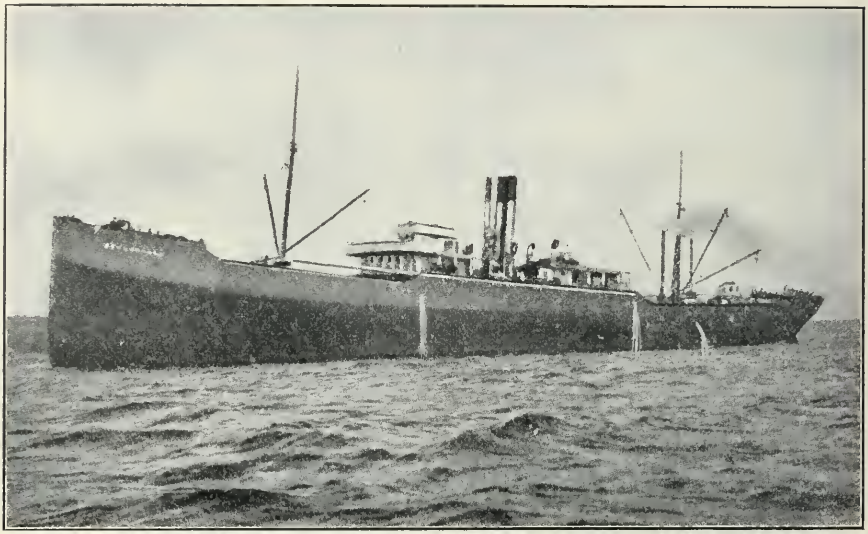


FIG. 2. ON THE ROCKS—HIGH TIDE.

both forward and aft were still so tight that they could be pumped dry, which was accordingly done, the boiler water, ballast water, and 500 tons of bunker coal being also got rid of. It was only necessary then to expel the water from the damaged hold, which was done by the use of air pressure. The space in which the water was to be displaced by the air admitted above it was 80 ft. long, 48 ft. beam and 27 ft. deep, there being no 'tween decks. The hatches were secured and made air tight and the deck and bulkheads were braced to resist the anticipated pressure and the compressor was connected and set to work.

The compressor used, shown in the half tone, Fig. 3, was an oil engine driven compressor known as Ingersoll Rogler, Class E R O. The oil engine and compressor cylinders are tandem or straightline with a common stroke of 10 inches. The former is 12½ inches in diameter and operates on the "two-cycle" principle. The compressor cylinder is 10 inches in diameter, double acting with a piston displacement, at 300 revolutions per minute, of 261 cubic feet. The compressor is capable of compressing and delivering air up to 100 pounds per square inch, and the fuel consumption is then about 3½ gallons per hour, but as in this case the pressure required did not exceed 6 pounds, this figure was materially lower.

The compressor, which, it must be conceded, was of rather small capacity for the work required of it, made a record run worth noting. It was located on the deck of the steamer itself, so that without any change of position or connections it was able to run continuously, not only to drive the air into the hold and drive out the water until the steamer was floated, but also to keep her afloat until she could be towed to Quebec and safely landed in a dry dock. It ran therefore without stop or breakdown for three weeks and one day, starting at 9 A. M. on August 22.

The salvage operation as a whole was by no means so simple as might be inferred from the preceding, and much care and judgment was demanded to secure the final success. The most ticklish part of the undertaking lay in nicely adjusting the vessel's draft, because she was so caught under hold No. 2 that only a few inches of leeway was allowed in regulating her trim. An even keel until she was clear of the rocks was not to be thought of. It was necessary that she should not draw more than 6 feet 9 inches forward and 14 feet aft, lest any acuter angle should increase the grip of the rocks even at high tide. Thanks to the skillful manner in which she was handled, the Hendonhall was freed about an hour and a half before high water on a moderate spring tide. At the time of her release her engine room was purposely

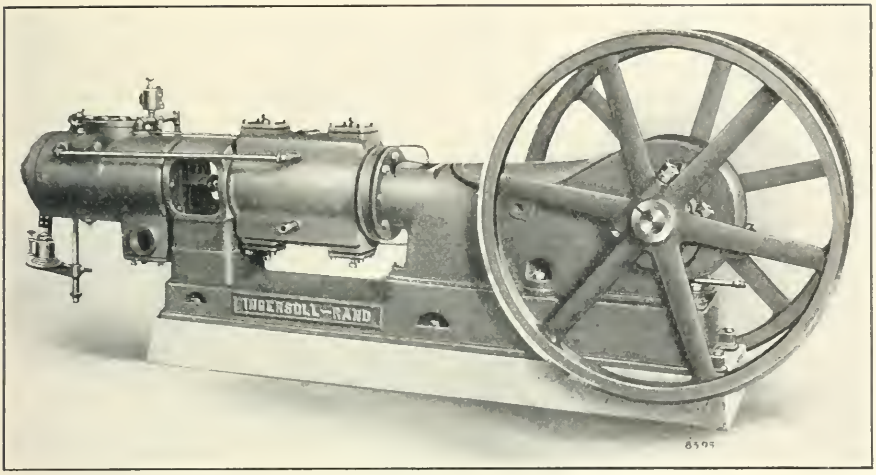


FIG. 3. OIL-ENGINE-DRIVEN AIR COMPRESSOR.

partly flooded and a quantity of water was carried also in No. 4 hold, not only to assist her trim by the stern, but to list her in order to facilitate her clearance.

The ship was thus kept afloat practically without a bottom, and was taken in that condition up the St. Lawrence to Quebec, a distance of about 250 miles. On the trip it was a simple matter to bring her to normal trim.

METAL MINING IN BOLIVIA

Bolvia has an area of 708,195 square miles, which is over twice the area of the Pacific Coast States of Washington, Oregon and California. The population is 2,268,000, LaPaz, the capital having only 82,000. It has no seacoast, being shut off from the Pacific by Peru and Chili, with Brazil north and east and Argentine and Paraguay at the south. It is also a rough country for railroad construction and operation, so that it remains to a great extent undeveloped. Its mineral wealth is shown by its recent exports under these unfavorable conditions. In the first five months of 1915 the export of ores and metals aggregated 20,894 metric tons divided as follows: tin, 17,055 tons; copper, 2,037; bismuth, 211; wolfram, 243; antimony, 1,315; silver ores; 33 tons.

This record suggests that here must be an inviting opportunity for the modern mining engineer. Our interest in this region is stirred by a personal letter from a mining engineer, Mr. F. A. Savage, who has recently come in touch with one of the active mines there. His letter gave an unusually realistic account of his voyage from New York to the Panama Canal, down the west coast of South America, and then up the western slope of the Andes until the mining region was reached at Catavi. We are compelled to omit all this, but the portion of his narrative which follows is quite in our line.

I will now attempt, he says, to give you a slight idea of the conditions that I have encountered at Llallagua (pronounced Yayagua) mine.

The mine is located three or four miles from Catavi and 1,500 feet higher. All the formation of the region is decidedly volcanic and hot springs are frequently encountered. About twenty miles distant there is an active peak which occasionally throws ashes around the mine site.

The tunnel entrance to the mine is known as Cancaniri. It penetrates the hill about 2,600 feet and then branches off into various workings of the mine. An electric railroad runs into this tunnel, and is used to convey the ore and waste from the mine. The locomotive is a General Electric, Single Phase, and has given excellent results.

The ore is brought out to a "coffing dump" and there is parted, entirely by female labor, and sacked for shipment. It is surprising to know that these women become very expert in classifying the ore, and seldom, if ever, does the ore which they have sorted fall below 60 per cent.

The upper mine, with another tunnel, is known as "Socabon Azul." A small amount of ore is extracted through this tunnel and sorted by the women, but most of it, however, is extracted through the lower tunnel, as there is direct connection between the two.

We have at the mine three Imperial compressors, one being WB2, 24 by 13 by 16 inches, and the other two being XB type compressors, the largest of which is 18¼x10¼x10 inches. The smaller one carries no plate, and has never been stopped long enough for me to get the exact size.

Considering the fact that we must run either the big compressor or the two smaller ones—on account of lack of power—I believe you can readily appreciate the fact that we are always short of air. Our pressure varies from 30 to 50 pounds, [which of course is always too low. Ed. C. A. M.] and it is a decided wonder to me that the machines have done as good work as the present indications show.

We have working at the mine now 43 Jackhamers, BCR-430, 21 BC21 stopers, 4 B104, 3 No. 18 Leyners, 5 Bolide (Francois type) Hand Hammers, and 3 Bolide (Francois type) stopers. I must add that we are running also one No. 3 and one No. 5 Leyner Drill sharpener with this air.

The photo [unfortunately not reproducible] shows a BCR-430 (regular Jackhamer) and it is an excellent illustration of the condition in which I found most of the machines at this property. All but one stud has been broken off the valve chest and the chest is tied to the machine with blasting fuse. I have in times past seen numbers of machines of different makes which have stood a great amount of abuse, but conditions at Llallagua Mine when I arrived here were such that I cannot even yet understand how the machines have stood the work.

Any one can readily understand what would happen to a normal Jackhamer piston, for instance, if, after the special hardening process as followed at the factory, it were placed in a blacksmith fire and heated to a white heat, then allowed to cool and after being filed replaced in the machine. That has been done here and it is merely one of the conditions encountered. There are other practices which would cover practically every spare part. The greatest difficulty encountered is in the objection which prevails as to the buying of repair parts for any machine. The idea seems to be that it is cheaper to buy entire new machines than to repair those on hand, and it makes the cost of machine drilling run up like the very devil.

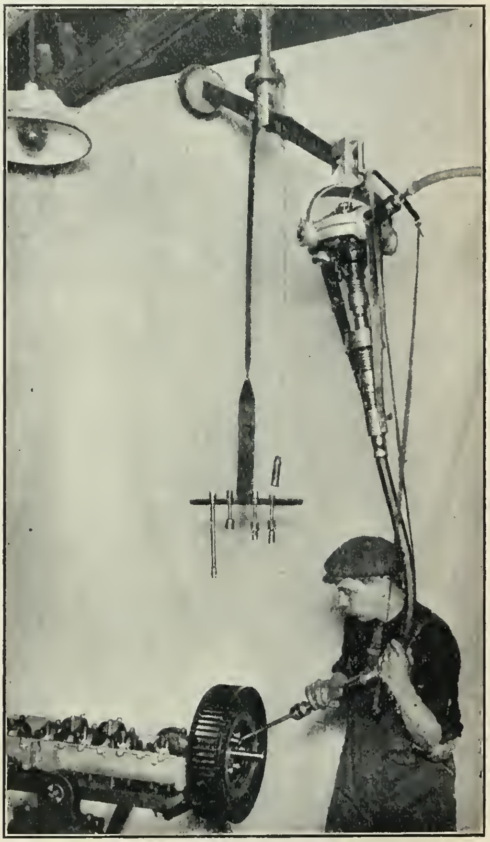


FIG. I.

TIME AND MOTION STUDIES LEAD TO PNEUMATIC TOOLS

The interesting photos here reproduced by the courtesy of Mr. Geo. D. Babcock, production manager of the H. H. Franklin Manufacturing Company, Syracuse, N. Y., show samples of the air operated labor and time saving devices employed in the manufacture of the Franklin automobile, facilitating and quickening production and reducing the cost of the output, besides lightening the work of the operators.

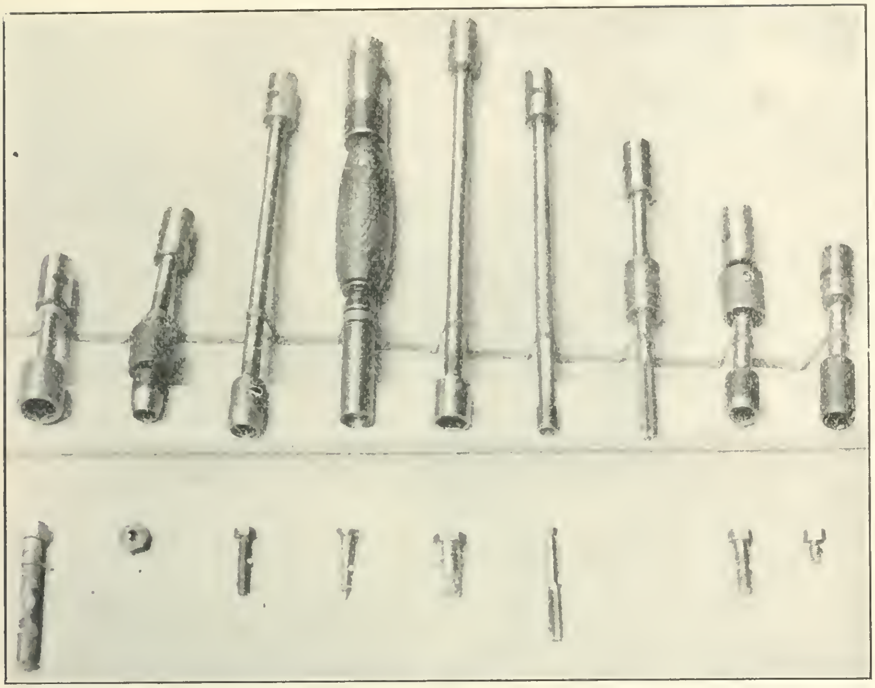


FIG. 2.

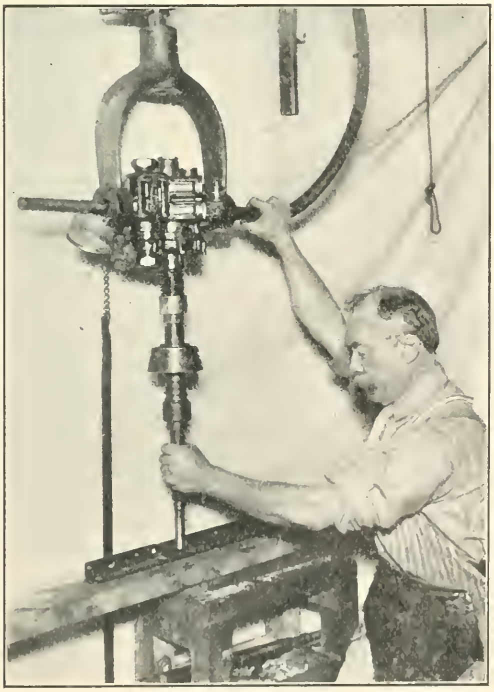


FIG. 3.

Where there many screws, nuts, studs, etc., on a machine, as is notoriously the case with every automobile, it takes in the aggregate a long time merely to tap the holes, insert and run home the screws, run on the nuts, etc., and while it is all light work human hands can only go so fast, and they tire quickly. In Fig. 1 we see just an ordinary boy doing work of this character with the aid of a pneumatic motor and it is worth while to note the elaborate provision which has been made for thus doing with quick repetition one of the simplest jobs of the shop.

The pneumatic motor overhead is mounted in a gimbal which allows it to tip freely in any direction, the gimbal being attached to the end of a lever which is weighted at the other end to balance the entire apparatus. The fork in which the lever is fulcrumed extends down from a trolley which runs on a horizontal rail. This spindle of the motor is extended below and connected to a flexible shaft which carries the special socket to fit the screw or nut to be operated on. In the spindle, before connecting with the flexible shaft, there is a friction clutch which is so adjusted that when the screw is driven home with the right tension it will

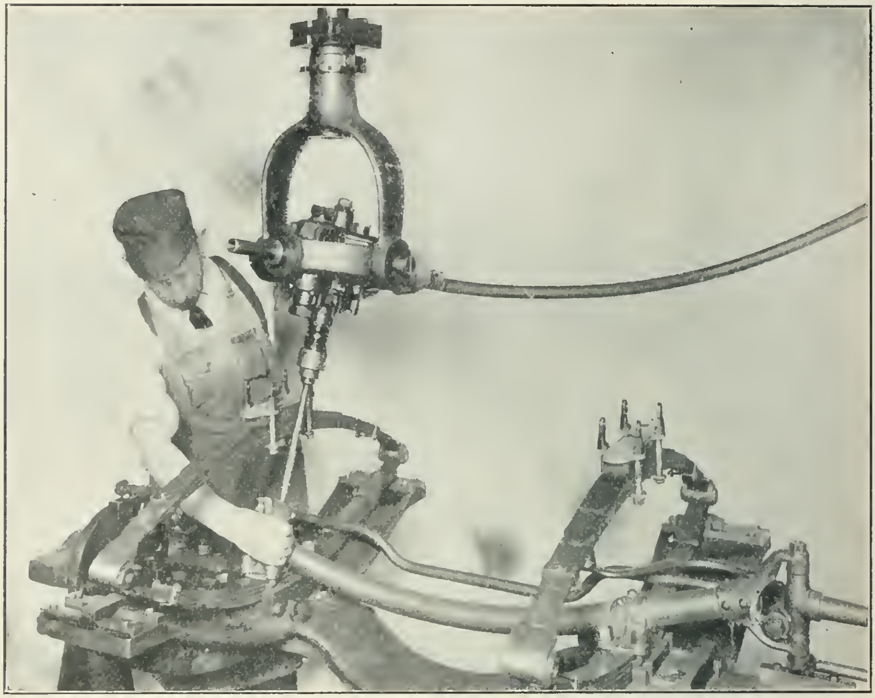


FIG. 4.

instantly allow the shaft to stop and nothing can be broken. Two light straps run up from the boy's hand to the ends of a cross lever that works the air valve. Convenient to the boy's hand is a rack with other sockets of different sizes and shapes for use as they may be required. Fig. 2, shows a variety of these sockets with the several pieces for which each is adapted. These seem to call for no special remark except perhaps No. 4, which is an ordinary wood-screw. That no time may be lost, an internally conical socket drops over the head of the screw, thereby finding the center so that the screwdriver drops into the slit immediately and drives the screw home at once. This woodscrew work is seen in operation in Fig. 3.

Fig. 4 shows the operation of driving front axle spring clip nuts, which requires no special mention. All parts in these several operations are arranged with safety stops and safety pins, the latter so that if any breakage occurs overhead the part will be stopped by a safety pin and will not drop.

Fig. 5 is a powerful compound lever device for clipping off the projecting ends of bolts.

The savings effected by some of these tools in the above establishment have been listed as follows:

1. Driving front axle spring clip nuts (Fig. 4) as compared with hand wrench 56%.
2. All engine studs, screws and nuts, 71%.
3. Rear axle tubes to rear axle gear case (no illustration) 41%.
4. Transmission studs and screws (no illustration) 68%.
5. Steel angle iron wood screws and other wood screwing on the sill 75%.
6. Bolt clipping 56%, special jaws lasting twice as long.

A LABORATORY WIND TUNNEL

By means of the "wind tunnel" of the Aëronautical Laboratory of the Massachusetts Institute of Technology experiments have been made upon a model sail to determine the true centre of pressure, the normal pressure per unit of area for a given wind velocity, and the proper angle of boom to centre line for fastest sailing over a given course.

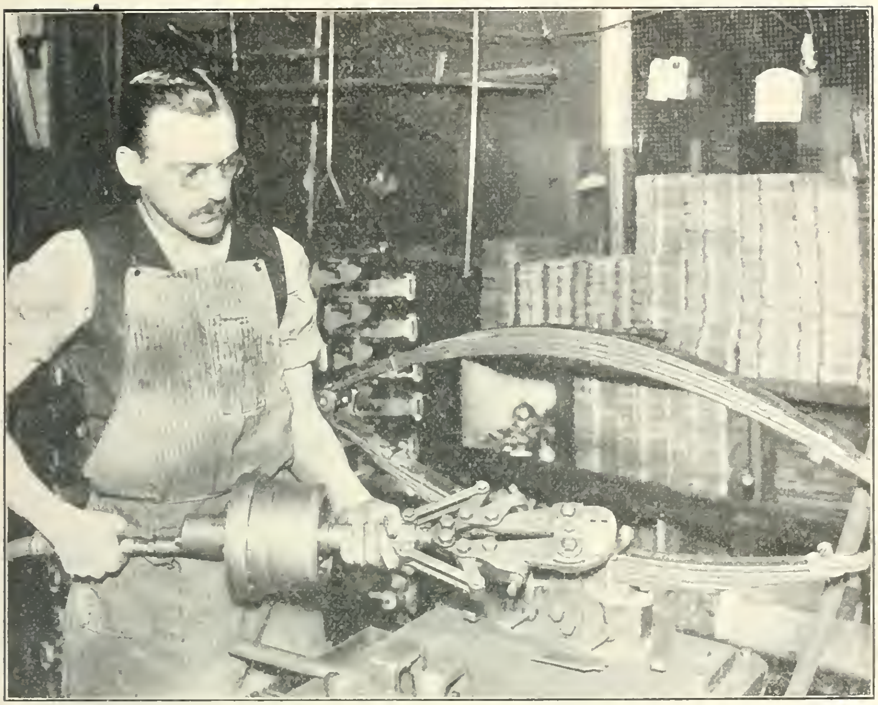


FIG. 5.

The "wind tunnel" consists essentially of a square duct, 4 feet on a side, through which a current of air is drawn at uniform velocity with a balance under it which supports the models to be tested and weighs the forces acting on them.

The experiments were carried out with a model of the mainsail of a racing yacht made to a scale of 3/8 inch to 1 foot. Among the other results of the experiments it was shown that for courses from 45 degrees to 160 degrees with the apparent wind (shown by the fly at the mast-head) the angle between the boom and the centre line of the ship for best sailing with this sail should be approximately one-half the angle between the fly at the masthead and the centre line of the ship.

FANS TO KEEP FROST FROM STORE WINDOWS

The Emerson Company recently received a letter from a central station superintendent, inquiring for an electrically-driven centrifugal blower for circulating outside air in two show windows through a series of six nozzles designed to impinge cold air against the plate glass at points approximately two feet apart for the entire length of the window, the object being to prevent the formation of frost during the winter months.

This user had, it seemed, tried the plan of boring numerous holes through the window casing at the top and bottom to admit cold air, and thus establish a circulation through the show window, but without success in preventing the formation of frost.

It has been well known for many years that the easiest way to keep frost off a show window is to take a small stationary type fan motor and run it steadily in the window, directing the breeze so that it will strike the glass and keep all the air in the show window in circulation.

The general circulation of air in a show window, whether warm air or cold air, has been proved to be sufficient to prevent the formation of frost even in extreme weather, as the fresh air which is constantly brought in contact with the inside of the glass evaporates any moisture which may be condensed on the cold glass, and in fact, almost entirely prevents such condensation.

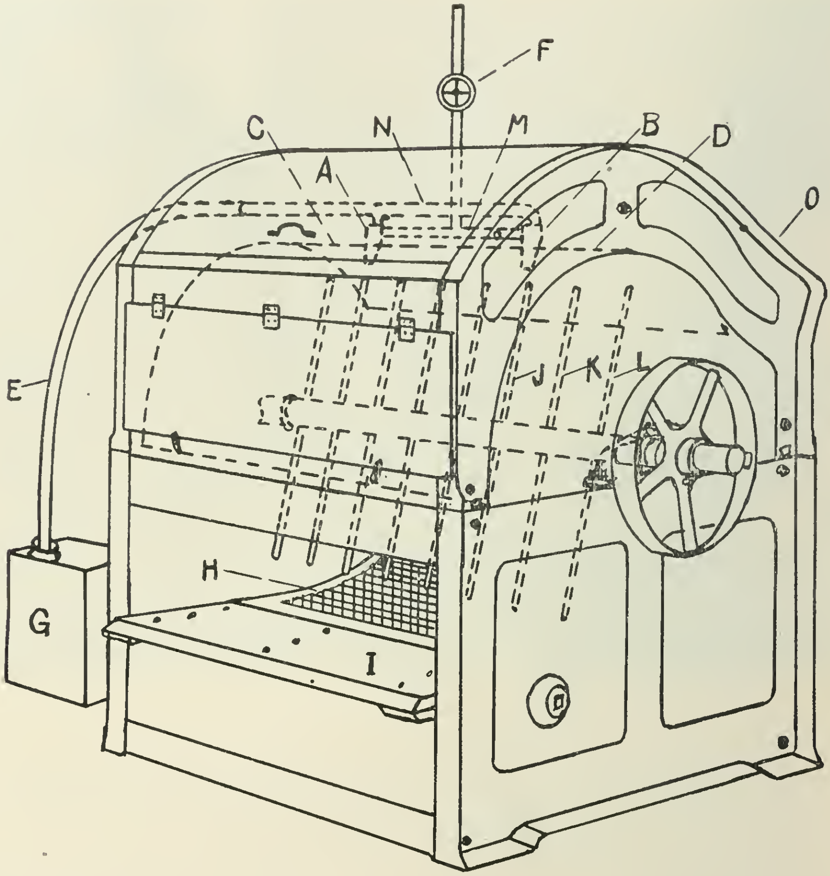


FIG. 1.

COMPRESSED AIR IN MATTRESS MANUFACTURE

BY CHARLES C. PHELPS.

In the manufacture of cotton mattresses, the first step in preparing the cotton body is to pass the cotton from the bale through a machine for separating the fibres and removing solid particles of dirt or other foreign matter. Various machines are used for this purpose, which are known as willows, dusters, pickers, etc. In all of them the cotton stock is pulled apart by rapidly revolving beaters or teeth mounted on a drum, as J, K, L, etc., in Fig. 1, which represents a willow viewed from the back. This action separates many particles of dirt as well as innumerable small particles of fibre which are thrown off in the form of dust. The heavy particles fall to the bottom of the machine and are usually caught beneath bottom gratings or screens H and removed periodically or continuously. In Fig. 1 "I" is the outlet door and the feed hopper is located at "O." In the making of high grade mattresses it is considered desirable to remove as much as possible of the dust, and for this purpose an exhauster fan and condenser often form part of the equipment by means of which the cleaned cotton, after being conveyed through a duct from the outlet of the willow, is "condensed" upon a rotating cylindrical wire screen and removed in a continuous sheet from the cylinder, while the dust passes through the meshes of the condenser screen and exhauster fan and is discharged as waste material. This arrangement is not included in Fig. 1. Considerable of the

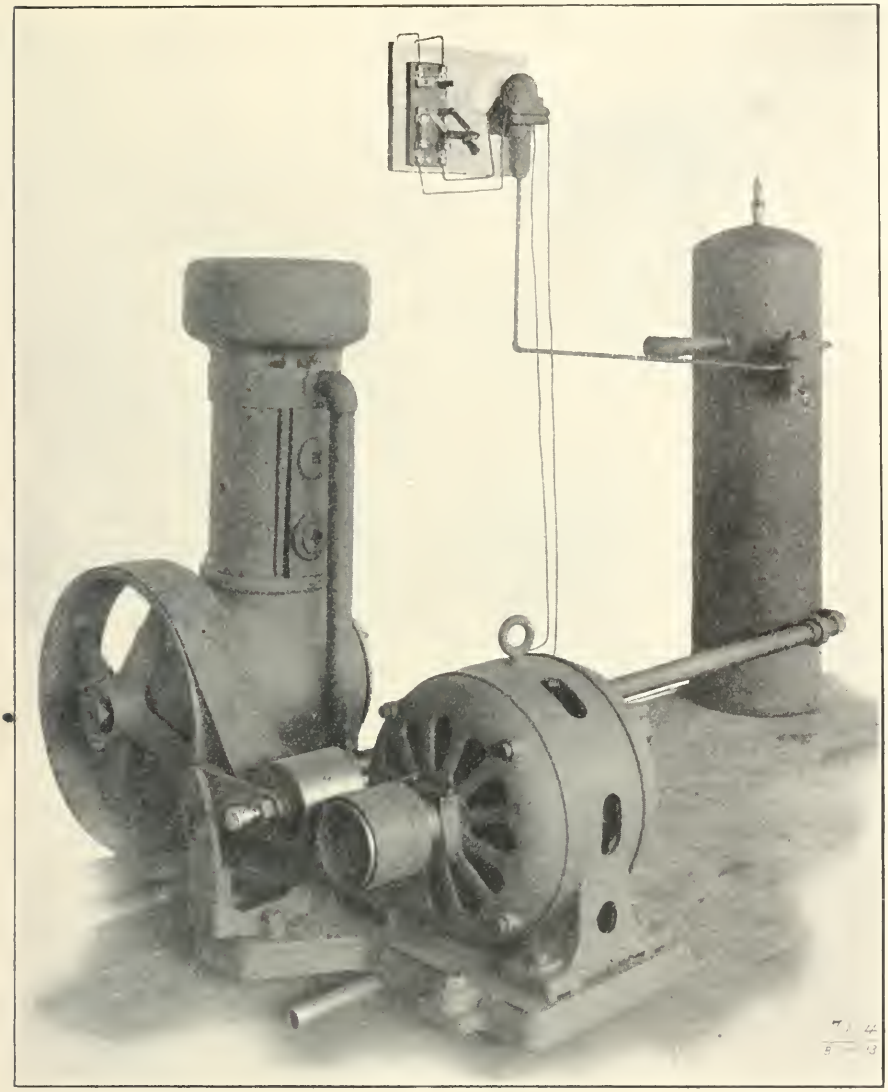


FIG. 2.

short fibre cotton is removed by this process, and as a result the weight of cleaned product will be found to be considerably less than the weight of the raw cotton.

For cheaper grades of mattresses more of the short fibre material is left in the cotton filling but heretofore this has been a source of annoyance due to the trouble with dust. This difficulty has been entirely overcome by spraying a small quantity of oil into the cotton stock while it is passing through the willow. This spraying does not interfere with the removal of the heavy particles of dirt which are thrown to the bottom of the machine; the dust, however, is completely allayed and remains in the stock instead of passing out of the machine. This spraying reduces the quantity of waste and is said to make the cotton more fluffy. At the same time, it makes the working conditions in the willow room more healthful, and reduces the fire hazard caused by the excessive dust formerly raised by the willowing operation. One spraying is sufficient for the entire process, allaying the

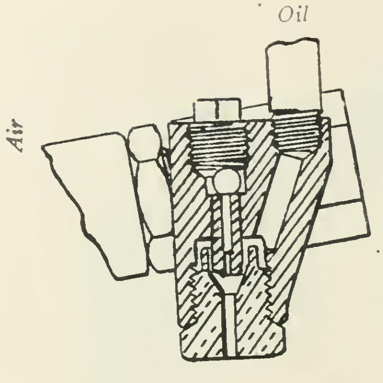


FIG. 3.

dust throughout all subsequent operations. The oil is not supplied in sufficient quantity to work through and stain the ticking covers, yet the men who sew the covers claim that mattresses are much easier to sew after applying oil to the filling. At one mattress factory which has used the oil spraying method for many months they state that they have never injured a mattress in any way by the oil treatment but consider that their product has been greatly improved thereby.

Any medium body odorless oil can be employed. A company operating mattress factories in Texas and Mexico employs a brand known locally as "Red Engine Oil" put up by the Pierce Fordyce Oil Co., which sells for about twenty cents per gallon. Five gallons of this oil is sufficient to treat thirty bales of cotton. As the average weight of cotton in a mattress is around forty pounds it is apparent that each mattress absorbs about one-tenth of a pint of oil.

Compressed air is employed for atomizing the oil. In the plants referred to above two sprays, A and B, Figure 1, are placed in the top of each willow, each spray located one quarter of the length of the willow from the end, so that the nozzle extends about one-half inch below the cylindrical screen C D, through which the fine dust and lint are ordinarily blown. Different styles of atomizing nozzles are employed. One type that has given satisfactory results is a small water spray, such as used on Jackhamer drills. This is illustrated in section in Fig. 3. The oil line, consisting of a three-eights inch pipe, enters the window through the end of the machine between the top of the screen and the cover and is connected with a five gallon can of oil by a length of rubber tubing. The half-inch air line is brought to the sprays through the top of the machine and has a valve conveniently located above the willow. The construction of the atomizing nozzle is such that the oil is lifted from the tank as well as sprayed by the air pressure. An air pressure of from 50 to 80 pounds per square inch is carried, and each spray requires about 2 cubic feet of free air per minute. Air is obtained from an "Imperial" Type XII Compressor of 3-inch stroke and 2½ inch bore, driven by a 1-½ horse power electric motor, short belted to the Compressor (Fig. 2). Air is discharged into a receiver, which equalizes the pressure.

In addition to the advantages mentioned above, the machinery is kept in a cleaner condition by using a compressed air jet periodically for blowing the dust and lint from its surfaces.

NEW METHOD FOR PURE IRON

It has been recently announced by the University of Illinois that a new method of producing pure iron, whereby a great saving can be effected in the electrical industries of the country, has been discovered by Trygve Yensen of the experimental bureau of the university. The new method consists in melting electrolytically-refined iron in a vacuum, and this reduces the impurities to a point far below that which has been reached by previous investigators. The magnetic properties of this vacuum-fused iron have proved to be as remarkable as its purity, its maximum permeability being reported to be about 20,000, or about seven times that of the sheet metal commonly used for transformer cores. The practical result of this investigation is obviously that the amount of iron required for the magnetic path in electrical machinery of all kinds can be reduced very materilly and the magnetic losses may be largely decreased. It is said that the University of Illinois has declined to permit a patent to be taken out on the process, as it is believed that the benefits from it should accrue to industry as a whole.

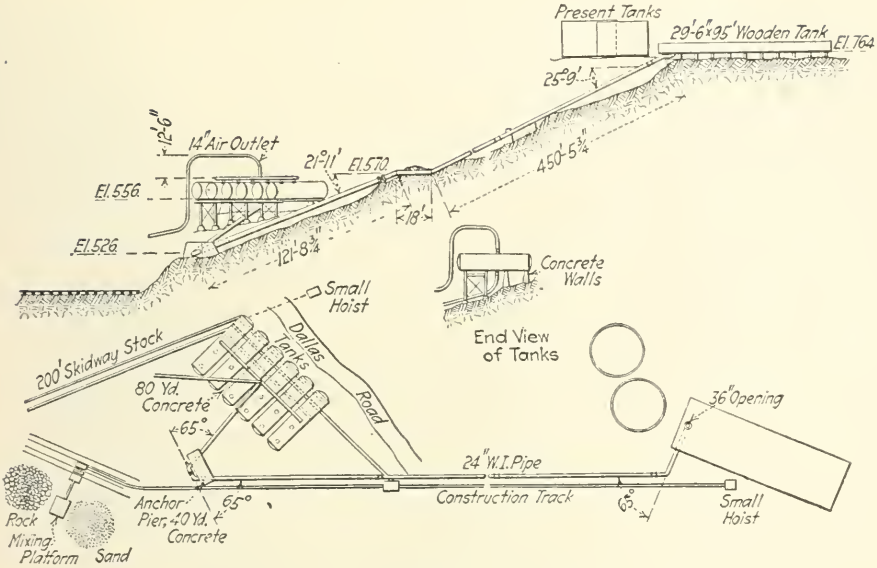


FIG. 1.

COMPRESSED AIR EQUALIZING SYSTEM AT COPPER QUEEN

BY FRED M. HEIDELBERG*

Power for the Copper Queen Consolidated Mining Co., Bisbee, Ariz., was formerly generated separately at five of the company's shafts. About the middle of 1908 a central power house was built. Five 400-hp. Stirling boilers, with economizers and superheaters attached, were to furnish the steam, two 3,500-cu. ft. per min. Ingersoll-Rand compressors were to supply the air, while three 500-kw. Curtis vertical turbines were to furnish the electrical power.

The air consumption was the big variable and worked the greatest ravages on the plant. The compressors were connected directly to the air system. The governors on all compressors were controlled so as to keep the pressure about 90 lb. gage. The equipment using air consisted of three main hoists—one Sullivan, one Fraser & Chalmers and one Nordberg—several hundred air drills and many other kinds of minor hoists and air machines distributed about the different shafts. It was found that since the Gardner mine hoist was so far from the power house, it could be run more economically on air than on steam; therefore air was used, thus adding another Sullivan hoist to the air-consuming engines. More mine development made it necessary to install a 7,000-cu. ft. per min. Nordberg compressor to take care of the increased air requirements. The average consumption of air during the year 1912 was about 10,000 cu. ft. per min., while the maximum and mimimum instantaneous requirements of the compressors were 14,000 and 2,000 cu. ft. per min. respectively. The minimum would take place between shifts when no air-using machines would be working. One 3,500-cu. ft. compressor would then run at little more than half speed. The maximum was furnished when all three compressors were running at full speed.

Naturally, the maximum instantaneous supply would take place when all hoists and most of the drills were working at the same time. The demand on the air system would be so great that all the compressors would jump from about half speed to full speed. Besides the undue racing of the compressors the demand on the boilers would be strong. Also, the air pressure would drop from 90 lb. to below 65.

Such conditions mean tearing the plant to pieces. Consequently, after a thorough investigation it was decided to install an air-storage

---

*Box 1179, Bisbee, Ariz.

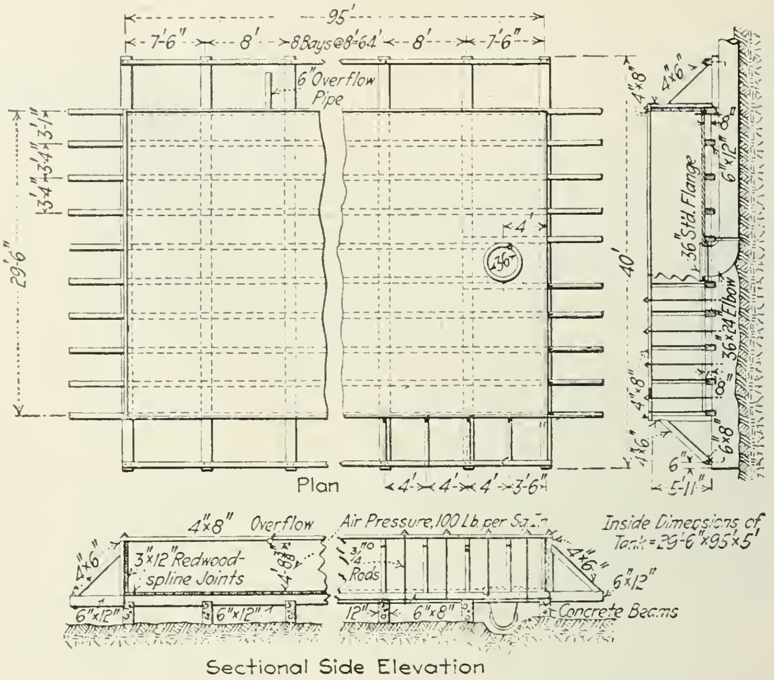


FIG. 2.

and balancing system which would store up the air when consumption was light for use when the air consumption was large, and keep the pressure nearly constant through a great part of the storage. This would allow fewer compressors in use and allow them to be run at a nearly constant speed. In essence the plant consists of a steel-tank storage for air kept at a nearly constant pressure by a hydrostatic head.

GENERAL FEATURES OF THE ARRANGEMENT.

The layout is shown in Fig. 1. The storage consists of six horizontal tanks, 9 ft. in diameter, 40 ft. long, spaced 11 ft. 6 in. centers. The volume of the six tanks is slightly over 15,000 cu. ft., and they will store approximately 115,000 cu. ft. of free air at 93 lb. gage.

The air outlet at the top of each tank is 8 in. diameter and connects to a single-piece 14-in. header with 14x8 welded tees. The water inlet at the bottom of each tank connects to an 18-in. header by means of 12x18 tees welded to the header. This 18-in. header connects with the 24-in. line of the water tank by means of a 24x18 tee. The 24-in. line is of wrought iron pipe and drops 30 ft. below the bottom of the tanks to form a U. At this U is a 24-in. gate valve. A 6-in. gate valve for draining and cleaning opens into the atmosphere at this point. From this U the pipe extends about 620 ft. to the wooden water-storage tank on top of the hill. The opening to the wooden tank is 36-in. and is connected by a 36x24 elbow.

There are five expansion joints in the pipe line, each allowing for a 2-in. expansion. Four of these expansion joints are between the U and the water tank and one between the U and the air tanks. Since one section of the long pipe is inclined to at angle of 21° 11′ and the other at an angle of 27° 11′, it would tend to slide down and close the expansion joints. Consequently an anchor pier 2x4 ft., top dimensions, extending with battered sides down to rock, was put in on the up side of each expansion joint to hold the upper section of pipe. Under each section of pipe a supporting pier 18 in. square on top was placed. At the U a large anchor pier was built. The pier was to have top dimensions of 6x21 ft. and was to extend with battered sides to rock not less than 4 ft.

Fig. 2 gives the details of the wooden water-storage tank. The dimensions are 29½x95x5 ft. The foundation consists of thirteen 12-in.-wide concrete beams spaced to make 95 ft.

These piers are built on the rock and upon them were placed ten 6x12's spaced to make 29 ft. 6 in. The sides and bottom of the tank were lined with 3x12 splined redwood. The bottom of the tank was nailed to the 6x12's, while the sides were nailed to 4x6's. Braces of 4x6 were then inclined, as shown, to hold the sides plumb. A 4x8 cap was then placed around the entire periphery of the tank. Both a water outlet and an inlet from the pump were provided.

The volume of the water tank is 2,800 cu. ft. per foot in height, which is slightly over one-fifth the volume of the air tanks. The total drop in head equals the drop in the water tank plus the rise in the air tank. The rise in the tanks varies for the same volume of water. At any rate one foot drop in head in the water tank displaces approximately 21,000 cu. ft. of free air at 93 lb. gage. This little example illustrates the delicacy of the system.

The water tank provides a large quantity of water with a small drop in head until the tank is empty. If there is just enough water in the system to bring the water to equilibrium when the air tanks are just full of water, the level of the water in the pipe will be about 108 ft. from the U, measured along the pipe. It is the volume from the bottom of the water tank to this point of equilibrium in the pipe that will produce the greatest drop in air pressure—that is, to zero gage. The length of pipe from this point of equilibrium to the bottom of the water tank is 512.2 ft., representing a volume of 1,630 cu. ft., approximately one-ninth the volume of the air tanks. This is a small quantity of air. It will be seen, therefore, that at no time should more water be put into the system than will just fill the air tanks at atmospheric pressure with the water at equilibrium.

The additional head of 30 ft. from the bottom of the air tanks to the U serves as a safety precaution. The air will just go around this point when the air pressure is between 103 and 105 lb. On a test at 103 lb. the system worked. When the pressure was raised to 105 lb. the air went around the bend and forced the column of water up with such force that part of the water-storage tank was wrecked.

The air tanks are supported at four places. The two back supports consist of concrete walls running under each tank. The two front supports are channel columns with channel struts between. The columns are directly under the tanks and were designed to take a load of 55,000 lb. each. Each tank rests in four cast-iron saddles, one over each support. Although the struts have no load to carry, they were designed to hold an empty tank at the center of the span, since the empty tank would be rolled over the beam in that manner while erecting. The curved air-delivery pipe is carried up 12 ft. 6 in. above the 14-in. header of the tanks to insure no water getting into the air system.

The distributing lines were located about as follows: In the power house the air discharge

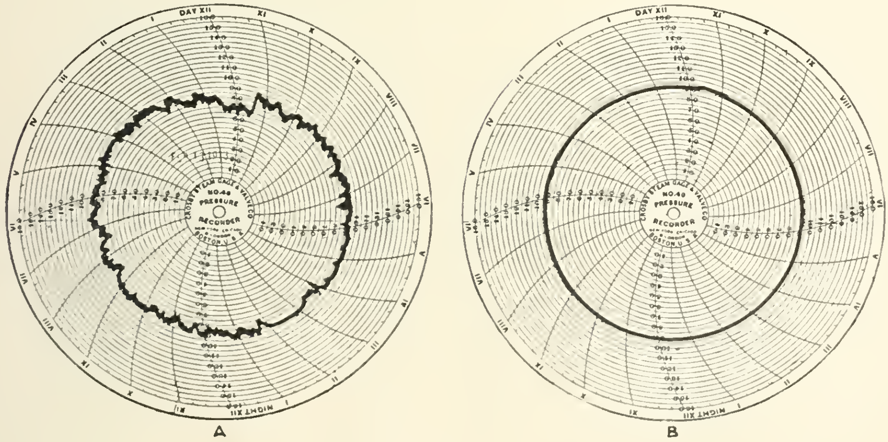


FIG. 3.

of all the compressors connected to a drum 4 ft. diameter and 80 ft. long. A 14-in. pipeline connects this drum with a smaller drain drum just outside of the power house. Two lines lead from this drain drum—one a 14-in. line connected to the balancing system several thousand feet away; the other, a 10-in. line, leads over to the Gardner shaft and supplies air to all the mines in the northern part of the camp. An 8-in. line connects to the 14-in. line near the balancing system, to furnish air to the Lowell shaft. Drain drums were provided wherever there was a dip in the pipe lines.

In order that the right amount of water should be got in the reservoir, a set of gage-glasses were connected to one tank of the battery so that the height of water in the air tanks could be ascertained. By closing the gate valve the water in the storage tank could be kept from varying until enough new water could be added to bring the quantity to the required amount. Outside of keeping the required amount of water in the tank, the system gives no trouble. Its operation is automatic, and the pressure rarely varies over three pounds.

By way of comparison, two pressure charts are shown in Fig. 3. Chart A is an average one before the balancing system was installed and shows the great variations in pressure in the air-supply system. It will be noted that in one place the pressure dropped and it was more than an hour before it could be brought up again. Chart B, on the other hand, was taken after the system was installed and shows very little variation in pressure during a 24-hr. period.—*Eng. and Min. Journal.*

HOW WAR SCATTERS THE METALS

Specifications for Russian 3-inch shells call for a loading of 258 to 260 half-inch bullets, consisting of 4 parts lead and one of antimony. This requires practically 4.908 lb. lead and 1.217 lb. antimony per shell. In addition, fine stibnite mixed with magnesium powder is used to produce the smoke that enables an observer to register the point at which the shrapnel bursts. This calls for 0.0238 lb. stibnite and 0.02322 lb. magnesium per shell. British 3.3 inch shrapnel uses even more lead, the total weight of the bullets being 7.92 lb. and the composition 7 parts lead to one of antimony. This shell also requires 4.04 lb. copper and 1.87 lb. spelter.

EXPLOSIVES IN ENGINEERING

BY CHARLES E. MUNROE.*

Although gunpowder is recorded as having been used as a propellant at the siege of Boza in 1323, its first appearance in military engineering operations was at the siege of Merat in 1397, where it was used for springing mines. In 1585 it had come to be used in marine devices, for in that year a bridge in Antwerp was destroyed by a floating torpedo. The first reputed application of this agent to peaceful pursuits is attributed to Martin Weigold at Freiberg, Saxony, in 1613.

INVENTION OF THE HIGH EXPLOSIVES.

For over two centuries gunpowder remained the only available blasting agent, but in 1845 Schoenbein discovered gun cotton, in 1846 Sobrero discovered nitroglycerine, in 1866 Nobel invented dynamite and a new era in explosives for engineering uses began. Guttmann dates the application of these new sources of energy to blasting as 1854, but without citing person, substance, or place. In the early days of blasting the charge in the bore hole was ignited through the stemming by spills or squibs, consisting of straws, quills or rush tubes filled with fine powder. In 1831 William Bickford invented the running fuse in use to-day wherein a thin, continuous core of powder, along which the fire might slowly travel at uniform and determined rate, was enclosed in a jute tube. In 1867 Nobel introduced detonators.

FIRING BY ELECTRICITY.

To-day the preferred method of firing blasts is by electricity; therefore Americans should be interested to know that history states that Franklin, in his Letters on Eléctricity (June 29, 1751), was the first to suggest the employment of frictional (or static) electricity for the ignition of gun-powder, and that in 1831, Moses Shaw of New York, made the first application of this method to the firing of mines. Meeting with practical difficulties in putting his invention into industrial operation Shaw, on June 1, 1831, appealed to Dr. Robert Hare of the University of Pennsylvania for advice and assistance, and the latter applied his famous deflagrator or voltaic battery and a wire bridge to this use with such complete success that, though the generators for the electric current have been altered in form and character, and the detonators in details, the method devised by Dr. Hare is the method which is to-day in universal use throughout the world for the firing of blasts, mines, or torpedoes by electricity. This method was demonstrated for use in warfare when in 1843 Samuel Colt blew up a brig under full sail in the Potomac from Alexandria, which was 5 miles distant from the brig, though in 1839 Sir Charles Pasley had removed the wreck of the Royal George at Spithead by the use of low tension fuses.

---

*From a paper before sections of the American Society of Mechanical Engineers, Providence, R. I., Dec. 18, 1915.

FLOOD ROCK.

The blowing up of Flood Rock in Hell Gate, in New York city, was successfully accomplished October 10, 1885. Flood Rock had a superficial area of nine acres, about 250 sq. ft. of which was above water. The rock consisted of horn-blende gneiss, with intersecting cross-veins. A sea-wall 7 ft. high was built around the island, and two shafts were sunk, one 67 and the other 40 ft. deep. The main shaft was used for removing the excavated rock in blasting out the headings. The smaller shaft was used for the tubes conveying the compressed air which drove the drills. The first series of headings branched out from the main shaft at a depth of 40 ft., and from the bottom of the shaft another series diverged directly under those above. The headings branched at right angles every 20 ft. and were 60 in number in each tier. The double system of headings was employed to gain a sufficient depth after the explosion without the necessity of dredging out to the extent that was found necessary at Hallet's Point. The total length of tunneling was about four miles, consisting of 24 galleries running north and south and 46 running east and west. The longest of these was 1,200 ft. in length, 6 ft. wide and 10 ft. high. There was a thickness of from 10 to 25 ft. between the roof of the top tier of galleries and the water. There were 467 pillars, 15 ft. square, left to support the roof. The whole rock was honeycombed with tunnels, about 80,000 cu. ft. of rock having been removed.

There were drilled in the pillars and roof 13,286 chambers for holding the cartridges, each chamber being 3 in. in diameter and about 9 ft. deep. These chambers were filled with rackarock cartridges, of which there were about 47,000 used, each being 2½ in. in diameter and 2 ft. in length, and containing about 6 lb. of the explosive. In addition to the rackarock cartridges, several hundred ordinary dynamite cartridges were used, to which the wires leading to the firing batteries were attached. The shock resulting from the explosion of these dynamite cartridges caused the explosion of the rackarock. Upwards of 285,000 lb. of explosives were used in the charge.

The wiring in the mine was divided into 36 circuits, the batteries attached to these circuits being stowed in a tool-house on the rock. The wire of the primary circuit which actuated the electro-magnet that closed the secondary circuits was led across to the Astoria shore on the morning of the explosion. The firing key was about 1200 ft. from the mine.

Two siphons, one 12 in. in diameter and the other 3 in., were set at work at 10 a. m., October 9, flooding the mine, and they completed their work early the following day. The first effect of the explosion was to produce a rumbling noise, and then to project a mass of water over an area of about 1200 sq. ft. to a height of about 150 ft. Masses of rock rose in the midst of this water to a height of from 40 to 50 ft. The explosion lasted about 30 seconds. As the water fell a dense cloud of yellowish smoke arose and floated over the Astoria shore.

After the explosion the rock appeared undisturbed, though on close examination it was found to be somewhat fissured. However, it slowly settled, and by October 13th the entire rock was below water. It was not intended that the rock should be broken very fine, since with the appliances at hand pieces of from ten to fifteen tons in weight could be most economically handled. The operation covered nine years, and cost upwards of $1,000,000.

EFFICIENCY IN THE USE OF EXPLOSIVES.

The following was published by the present writer in 1900, in the Popular Science Monthly:

There is a widespread misapprehension in regard to the devastating effect of these high explosives, for when unconfined the effect even of large charges of them upon structures is comparatively slight. At the Naval Ordnance Proving Ground, so long ago as 1884, repeated charges of dynamite, varying from five to 100 lb. in weight, were detonated on the face of a vertical target consisting of eleven 1-in. wrought-iron plates bolted to a 20 in. oak backing, until 440 lb. of dynamite had been so detonated in contact with it, and yet the target remained practically uninjured; while at Braamfontein the accidental explosion of 55 tons of blasting gelatin, which was stored in railway vans, excavated but 30,000 tons of soft earth. This last may seem a terrible effect, but the amount of explosive involved was enormous and the material one of the most energetic that we possess, while if we compare it with the action of explosives when confined, its effect becomes quite moderate.

At Fort Lee, on the Hudson, but two tons of dynamite placed in a chamber in the rock and tamped brought down 100,000 tons of the rock; at Lamberis, Wales, 2½ tons of gelatin dynamite similarly placed threw out 180,000 tons of rock; and at the Talcen Mawr, in Wales, seven tons of gunpowder, placed in two chambers in the rock, dislodged from 125,000 to 200,000 tons of rock. We might cite many such examples, but on comparing these we find that the gunpowder confined in the interior at the Talcen Mawr was over forty-two times as efficient as the explosive gelatin on the surface at Braamfontein, while the dynamite at Fort Lee was over ninety times as destructive.

These views have received but little consideration from officials in this country and our Government has gone on spending money in the testing and use of devices which were certain to prove ineffective. However, I confidently point to Liege, to Namur, to Antwerp and to the effects of a multitude of perforating high explosive shells used in the present war in confirmation of the principles I developed.

Shortly prior to 1898, and while he was Chief of Bureau of Ordnance, U. S. N., I was asked by Captain Sampson to assist in the tests of armor piercing projectiles then being conducted at Indian Head by Comdr. Couden by securing a high explosive charge for them. This was done and after proving an excellent degree of fragmentation in the fragmentation pit a shell containing 8.25 lb. of the explosive was fired through 14.5 in. of the Harveyized armor of the U. S. S. Kentucky and exploded on the inner side. So far as records go this had then never been approached.

When Admiral Sampson took command of the fleet he wrote me asking my assistance in securing high explosive charges for the armor piercing projectiles of his fleet. I delivered his message and used my best endeavor, but the material called for was not sent and it remained for the Japanese to be the first to demonstrate in practice the soundness of these principles.

This study was continued and extended to bore-holes in blasting operations by my pupils, Clarence Hall and W. O. Snelling, and their results and conclusions were published in 1912 as Technical Paper No. 17 of the Bureau of Mines under the title "The effect of stemming on the efficiency of explosives." It was naturally of interest to learn that a manager of a considerable mine reported a saving of $50,000 in his explosives' account in a single year by following the methods for using stemming taught by this research.

More recently Edgar A. Collins has stated in Min. Sci. Press, Vol. 110, p. 790, 1915, that he has found in practice where 30 per cent. ammonia gelatin was being used in a given mine a saving of 25 per cent. in quantity of the explosive was effected by increasing the depth of the tamped stemming above the charge, and that as a consequence the amount of explosives issued to the miners had been cut to from 10 to 20 per cent. of that formerly issued.

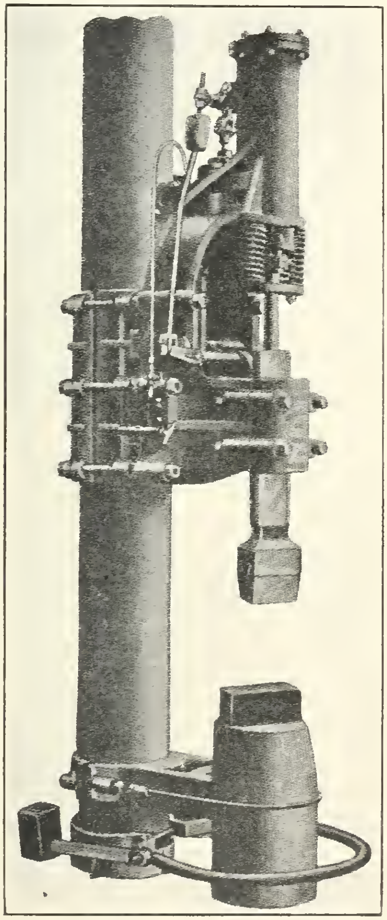
POISONOUS GASES.

It should always be remembered that the gases produced by explosives in exploding have other properties than that of yielding larger volumes than the solids from which they are produced, for some of them are poisonous. The kind of gases produced differs with the kind of explosives used and the way in which it is used. Nitric esters and nitro-substitution compounds and the mixtures, such as dynamite, made from them, may yield poisonous nitrogen oxides and cyanogen, and poisonous and inflammable hydrogen sulphide and carbon monoxide. But if the explosive be properly compounded, well confined, and fully detonated, these harmful gases will not be produced, for the gaseous products will then be largely composed of water and carbon dioxide; and though carbon dioxide may cause unconsciousness and even death, it does so only when it forms a large proportion of the atmosphere. Blasting powder and gunpowder-like mixtures give off poisonous and inflammable hydrogen sulphide and carbon monoxide under all conditions of explosion.

The production of inflammable gaseous products underground, especially in coal mines and bitumen mines, is most hazardous. The production of poisonous gases, either below ground or on the surface, is a source of danger, and if such gases are formed they should be removed by ventilation before anyone is allowed to approach the working place. Neglect of this precaution led to the death of 7 persons and the rendering of 40 others unconscious from gas poisoning following the firing of 21,000 lb. of blasting gunpowder at the Crarae quarry, Loch Fyne, Scotland, on September 25, 1886. The quarry was situated in a basin in a hill with sides rising 25 to 250 ft. and was approached by a narrow gorge. The blast was fired in the presence of an audience of over 1,000 persons and at least half an hour after the blast 120 got into the quarry to observe the effect, and within five to six minutes after entrance they began to fall, overcome by the poisonous powder gases entangled in the crevices of the rock that had been thrown down.

In a large engineering project in the West nine men lost their lives as a result of the poisonous gases produced on the detonation of 40 per cent strength gelatin dynamite in a long tunnel. After igniting the blast the men retired about 500 ft. to wait for the smoke to clear, and while they were waiting the smoke drifted slowly over them, and then, owing to some change in the air current, drifted slowly back again. The men felt the usual symptoms of carbon monoxide poisoning—slight choking, nausea, profuse perspiration, and headache—but they all revived upon reaching the open air about an hour and a half after the blast had been fired. Within a short time, however, the men began to cough and spit bloody mucus and show other symptoms of nitrogen peroxide poisoning. In less than three days 9 out of the 13 men who had been in the tunnel and exposed to the fumes had died; the other four, as well as those who went in with the motor to bring out the men, were ill for days and even months after the catastrophe.

It was soon after the accident mentioned above that special studies of the noxious gases evolved on the detonation or combustion of different explosives were undertaken by the Bureau of Mines to determine whether improvements could be made in the composition of explosives with a view to increasing safety in mining.



IMPROVED POST HAMMER

The halftone shows a post hammer recently brought out by the Q. M. S. Company, 2059 Elston Avenue, Chicago, which speaks for itself as to its general handiness and adaptability. It originated in connection with tool forging, but is good for a wide variety of work, and while it may be operated with either steam or air it is, as is the general experience, more lively and satisfactory with the latter and, on account of the intermittent service, the power expense is quite negligible

The action of the hammer is entirely controlled by the treadle. If it is brought down to the limit the heaviest blow results, like that of a drop hammer, and the force will be proportionally less accordingly as the treadle is less depressed. With a shop supply of air maintained for general use the hammer is always fully ready for work.

COMPRESSED AIR IN CONSTRUCTION AND REPAIR WORK.

BY CHARLES C. PHELPS

In connection with construction and repair work both above and under ground there are many operations that can be performed much more economically and expeditiously with the assistance of compressed air than by any other known means.

PORTABLE COMPRESSORS.

In many instances it might not be advisable to construct a stationary compressor plant or to pipe air from an existing plant located at a distance, owing to the temporary character of the work. The average up-to-date coal-mining property is equipped with an electric transmission system, and under these circumstances one of the most convenient means of obtaining compressed air for use in construction and repair work is by employing electric motor-driven portable compressors. Truly successful apparatus of this type is of comparatively recent development, and it is the intention to discuss in this article only the various types of electrically driven outfits and their uses. It should be borne in mind, however, that corresponding machines driven by other prime movers, such as gasoline, oil or steam engines, are sometimes better adapted to existing conditions and, as a matter of fact, are in extensive employment.

JACKHAMERS.

Construction that must be prosecuted at one time or another outside of the coal mine usually involves rock cuts and the removal of boulders in connection with grading for tracks or roads, digging trenches and pits, removing old concrete and masonry construction and the like. For these purposes Jackhamers, operated by compressed air, are highly economical, drilling from 100 to 200 ft. of hole per shift, whereas one-tenth of this footage could not be obtained in all probability in the same time by hand.

PNEUMATIC RAMMERS.

In building concrete foundations, culverts, bridges, dams, sluices, buildings, etc., pneumatic concrete rammers are often used to advantage. A Belgian engineer who made a study of this subject found that the number of blows struck played a far more important part in compacting the concrete than the force of the blow. It follows that the pneumatic rammer, which strikes approximately 600 light blows per minute, is ideal in comparison with hand ramming in which the maximum speed obtained is 50 or 60 blows per minute. This conclusion is verified by a test made with small cubes in which 60 blows left the concrete with a resistance of 2,844½ lb. per sq. in., 40 blows with 2,460¾ lb. and 20 blows with 1,538 lb. A similar test with hand ramming gave a resistance of only 939 lb. per sq. in. The hand rammer used weighed 33 lb. and was permitted to fall from a height of 20 in.

It is apparent that by obtaining a stronger product by tamping, a lighter structure will often serve the purpose, saving considerably in cost of materials and workmanship. Pneumatic tampers of a different type are being adopted extensively for tamping railroad ballast.

PNEUMATIC DRILLS

In the construction of steel or wooden bridges or trestles, laying tracks and erecting steel or wooden structures of various kinds, pneumatic tools are invaluable. Pneumatic drills, are used for drilling metal, boring wood, reaming, tapping, operating jacks, cranes, hoists and grinding wheels and small circular saws. They are also of great advantage for running in lag screws and tightening nuts. In one case a gang of seven men put up from 80 to 100 hangers in 9 hr., each supported by two ¾-in. lag screws. The holes were bored with pneumatic augers using ⅝-in. bits, later driving the screws home by means of the same motors used with extension sockets. This is at least double the work that could be performed under similar conditions by using augers and wrenches operated by hand.

PNEUMATIC HAMMERS

There is no comparison to be made between pneumatic riveting hammers and hand methods for heading rivets. Compressed air is also convenient for blowing rivet-heating forges.

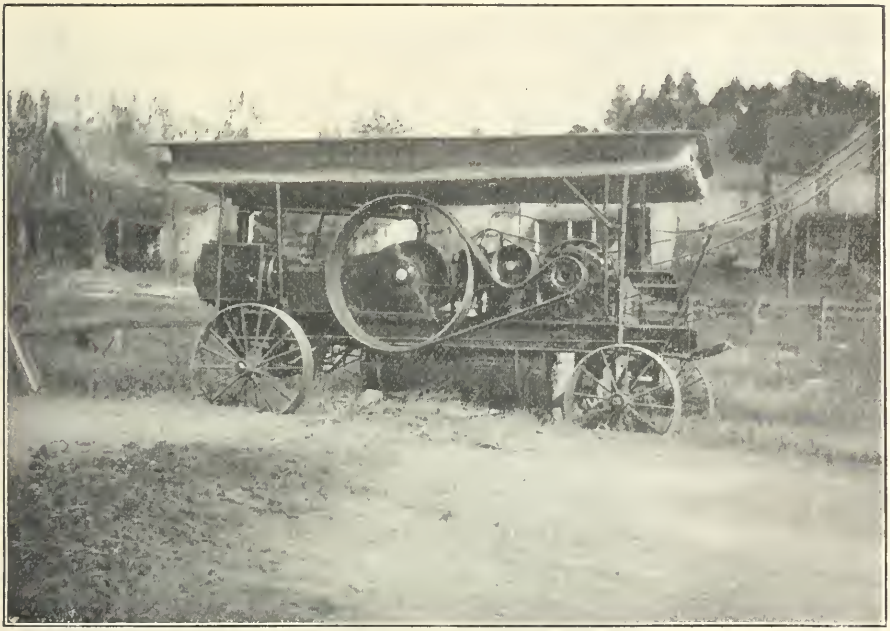


FIG. 1. PORTABLE ELECTRIC DRIVEN AIR COMPRESSOR.

Riveters can be fitted with a handy rivet "busting" attachment and have been adapted to driving spikes. In one case they were used for driving 9-in. spikes at the remarkable rate of 5 sec. each. On the same job a number of ⅞-in. bolts 38 in. long were each driven by compressed air in 1 min. as against 18 min. by hand.

Pneumatic chipping hammers are invaluable for trimming, cutting and calking metal and may be fitted with a special chisel for such work as peeling the bark from logs in preparing ties or props. This last is a new application of this tool which is capable of great savings. It is said that the most expert tie peeler is capable of peeling by hand an average of 100 ties per day of 10 hr., but the average output is nearer 50 ties per day. Experiments have shown that an inexperienced laborer has no difficulty in thoroughly peeling from 150 to 200 ties per day with a special air-operated tool. These tools do not consume much air, but even with this expense added, there is a large saving over the old method.

In connection with repair work the opportunities for using pneumatic appliances are almost without number, for it is in this class of work particularly that it is often desirable to take the tool to the part to be repaired instead of taking the part to the shop. The greatest savings effected with portable pneumatic tools often pertain to the avoidance of costly delays incident to some minor part giving way and affecting the operation of important machinery.

In addition to the applications outlined, pneumatic drills are used for grinding and reseating valves, for reboring cylinders and for operating large valves and small machines. Chipping hammers are used for quickly cutting out sections of pipes and sheet-metal work and for scaling rust and paint from metal surfaces. The cement gun, the sand-blast machine, pneumatic paint and whitewash spraying machines, pneumatic displacement pumps and air-operated reciprocating pumps are other devices of the greatest value in repair and construction work.

MISCELLANEOUS USES OF AIR

Many of the appliances mentioned also find everyday application about the shop and power plant. A few of these applications may be enumerated as follows: Setting locomotive valves; expanding boiler tubes and flues; cleaning scale from boiler tubes with the aid of pneumatic drill motors; beading tubes and calking sheet metal with chipping hammers; drilling anchor-bolt holes in concrete machinery foundations; blowing out the air spaces of electric motors, the flues of boilers and other inaccessible places by means of an air jet. Compressed air is also commonly used for testing the tightness of pipe lines. Air from a stationary compressor is not available in some of the smaller plants, and in such cases a portable unit might be used to advantage.

VARIOUS TYPES OF PORTABLE COMPRESSORS.

Having defined the field of the portable compressor in general, the various types will now be described briefly. The mine car compressor is the most suitable type for underground operations. During the past few months it has been adopted extensively for operating hand drills, mounted cutting machines, punchers, pneumatic tools, etc. After a brief try-out that demonstrated beyond doubt their economy, one Pennsylvania coal mine purchased 14 of these outfits, and many other mines in various parts of the country are starting to use them.

This equipment is a self-contained, self-lubricating, electrically operated unit, totally inclosed as a protection against the entry of dirt to the working parts. It can be started up by the miner and will run without further attention while he is drilling the coal or rock, excepting occasional replenishment of water in the reservoir cooling jacket surrounding the compressor cylinder. It may be quickly and easily moved over the regular mine tracks to any part of a mine and can be set up and connected with the regular mine power wires in a short space of time. This type of compressor is made in capacities ranging from 78 to 415 cu.ft. of free air per minute.

The mine car compressor is equally suitable for use above ground provided the work is situated within a few hundred feet of the tracks over which it runs. Fig. 1 illustrates a type that is perhaps better suited for general conditions above ground, as it can be transported by horse or other power to almost any location. The entire outfit is mounted on a covered truck. It is built in various capacities ranging up to 464 cu. ft. of free air per minute.

The cost for power of such an equipment is less than would be expected. Consider the case of a motor-driven compressor of 145 cu. ft. displacement. This would require a motor with a horsepower input of about 25 for 70 lb. air pressure. Three cents per electrical horsepower per hour is undoubtedly a liberal allowance for power in coal-mining regions. Interest, depreciation and repairs figured at 25 per cent. of the initial investment of such an equipment would amount to about $200 per year—a liberal estimate. Based on 300 working days per year, one shift per day, this figure would reduce to about 67c per shift.

Supposing the work under consideration is the digging of a wide ditch through rock, employing two hand drills for an 8-hr. shift, the cost would figure about as follows per shift:

Operator	$4.00
Two-drill runners at $2.50	5.00
Lubricating oil	.50
Power for air, 25 hp., 8 hrs. 3c per hp. hr.	6.00
Interest, depreciation and repairs	.67
Total per 8 hr. shift	$16.17

No reduction is made in power charge for unloaded periods, which would undoubtedly reduce this charge considerably.

The footage accomplished with a Jackhamer drill is usually between 100 and 200 ft. of hole per day, depending upon conditions. We shall assume 150 ft. as an average accomplishment. The two machines would therefore drill 300 ft. per day. Thus the cost per foot of hole drilled would amount to $0.0539.

Under similar conditions the two drillers could put in by hand not over 20 or 30 ft. of hole per shift, employing the "single-jack" method. Assuming the same rate of wages and an average accomplishment by hand of 25 ft. per 8-hr. shift, the labor cost would be $5 for the two men, and the cost per foot of hole 20c.; in other words, machine drilling with the portable compressor, including all charges, would result in a saving of $0.1461 per ft.; that is, a saving of about 75 per cent. The cost of sharpening steel has not been included in the foregoing estimate as it would be about the same per foot in each case.

Fig. 2 shows a convenient type of portable compressor for use in shops, power plants and other places where a small amount of compressed air is required. The compressor proper is an air-cooled Imperial type XII vertical machine having a capacity of 6-cu. ft. displacement. A type of short belt drive similar

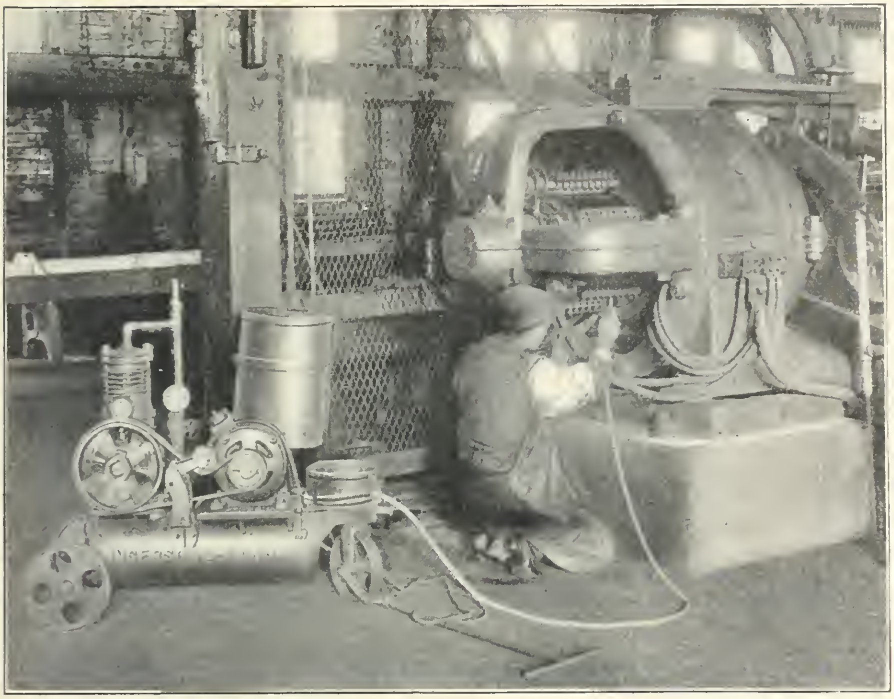


FIG. 2. HANDY PORTABLE SHOP COMPRESSOR.

to that used on larger machines is used to connect motor and compressor. The air receiver forms the body of the truck, and on it are mounted compressor, motor and all accessories, including a 20-ft. coil of air hose, plug and switch, wire, etc.—*Coal Age.*

ACTION OF GASOLINE VAPOR IN AIR

BY GEORGE A. BURREL.

Gasoline vapor mingles with air in the same manner that water vapor does. At any particular temperature a definite proportion of water vapor will be found in the atmosphere if it has become completely saturated, a condition that seldom exists. Usually a limited supply of water has been given off into the air, and the atmosphere is spoken of as having a certain relative humidity, meaning that the saturation is incomplete or that more water vapor could exist in the air were a source of moisture available. In a similar manner gasoline vapor mixes with air. The amount of vapor carried will depend on the temperature of the air and the readiness with which the vapor can be obtained.

If gasoline is exposed to the air of a room and for a long enough time, the air will contain at a certain temperature a fixed proportion of gasoline vapor, differing for different grades of gasoline, that can not be exceeded. The author has worked out the values for four different grades. The results for a temperature of 17.5° C. (63.5° F.) are shown in the following table:

Proportions of different grades of gasoline vapor that air will carry at a temperature of 17.5° C.

Grade of gasoline	Proportion of gasoline vapor (per cent).
Cleaner's naphtha	5.0
64° B. gasoline	11.0
69° B. gasoline	15.0
73° B. gasoline	28.0

It will be noticed that air will hold almost six times as much vapor from the lighter gasoline as from the heavier cleaner's naphtha. If the lighter and better grades of gasoline are heated, their vapors, when a light is applied, also flash and burn at lower temperatures than do the heavier grades. This difference does not mean that some gasoline is a dangerous inflammable liquid and some is not. All grades are classed as highly inflammable and dangerous liquids.

COMPARISON OF INFLAMMABILITY OF GASOLINE AND OF GASOLINE VAPOR.

If one takes the cover off a full pail of tightly inclosed gasoline and applies a match to the surface, the gasoline will flare up and burn as long as the gasoline lasts. On the other hand, if one puts a few drops of gasoline in a small tightly inclosed pail, waits a few minutes, and then introduces a flame or an electrical spark a violent explosion will most likely result. In the first case the vapor burns as fast as it comes from the gasoline, and mixes with the oxygen of the air. In the second case the oil vaporizes in the pail and mixes uniformly with the air therein to form an explosive mixture and upon ignition explodes. Consequently, when one hears of a disastrous gasoline explosion one may be sure that the explosion resulted from the mixing of the vapor from the gasoline with air in the proportions necessary to form an explosive mixture.

One gallon of gasoline when entirely vaporized produces about 32 cubic feet of vapor. If a lighted match could be applied to pure gasoline vapor in the absence of air no fire or explosion would result. Gasoline, liquid or vapor, like any other combustible material, needs the oxygen of the air in order to burn.

EXPLOSIVE RANGE OF MIXTURES OF GASOLINE VAPOR AND AIR.

It is fortunate that gasoline vapor, like other gases and vapors, needs a certain proportion of air before an explosion can take place. The author found that in 100 parts by volume of air and gasoline, an explosion will not take place if there is less than 1.4 parts of gasoline vapor or more than 6 parts. In other words, the explosive range is between 1.4 and about 6 per cent. of vapor. Flashes of flame will appear in mixtures containing considerably smaller or larger proportions of vapor, and considerable pressure will be developed, but propagation through the mixture will not take place.

Although the range of explosibility mentioned is narrow as compared to that of many other mixtures of combustible gases and air, yet the proportion of gasoline vapor representing the lower limit is small and indicates the great importance of not allowing even a little gasoline to be exposed in a room, because of the small quantity of vapor needed to make an explosive mixture with all the air in the room. If 1 gallon of gasoline is allowed to change completely into vapor simply by exposing it to the room air, and if the room is gastight, the 1 gallon can render explosive 2,100 cubic feet of air, the amount contained in a room measuring 21 by 10 by 10 feet.

In the actual use of gasoline such conditions seldom exist. However, an assumed case may be that of a person filling an open pail from a larger tank or using gasoline for cleaning. When the pail is first filled with the gasoline, a small volume of pure gasoline vapor forms over the surface of the gasoline. Just above this layer of pure gasoline vapor is a mixture of vapor and air; at some point there will be an explosive proportion, and farther away from the pail there will be a small proportion of vapor, and finally still farther away no vapor at all, but pure air. However, all the time the user of the gasoline is at work, the vapor keeps forming, from both the gasoline in the pail and that applied to the object being cleaned, rendering more and more air inflammable or explosive, until finally there will exist a dangerous atmosphere that may completely surround him, so that a chance ignition will envelope him in flames and perhaps cause great damage to property. Ignition of the gasoline vapor may take place even some distance from the gasoline in a room adjoining the room in which the person works. As the gasoline evaporates, and more and more vapor is given off, it mixes with air farther and farther from the gasoline and, if the evaporation lasts long enough, may travel to an adjoining room, where it may be ignited. On ignition a sharp flash will travel back through the adjoining room to the room where the gasoline is. *From Technical Paper 127, Bureau of Mines.*

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE
Compressed Air Magazine Company
Easton, Pa.
New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. FEBRUARY, 1916. No. 2

CONTENTS

Refloating the Hendonhall 7875
Metal Mining in Bolivia 7877
Motion Studies and Pneumatic Tools .. 7878
Laboratory Wind Tunnel 7880
To Keep Frost from Store Windows .. 7881
Compressed Air in Mattress Manufacture 7882
New Method for Pure Iron 7884
Compressed Air at Copper Queen Mine 7885
Explosives in Engineering 7888
Improved Post Hammer 7891
Compressed Air in Construction Work. 7892
Action of Gasoline Vapor in Air 7895
The Nation's Engineers to Help 7897
Compressed Air and the Railroads 7897
Screw Pipe Joints 7898
A Compressor Explosion 7898
Pneumatic Blacksmith Hammer 7899
Freezing of Air Brake Pipes Prevented 7900
Mining Engineers in the War 7901
Flotation Paradox 7901
Pneumatic Method for Measuring Hides 7902
Notes 7902
Patents 7903

THE NATION'S ENGINEERS TO HELP.

The following letter, dated January 13, was addressed by President Wilson to Mr. W. L Saunders, President of the American Institute of Mining Engineers and Vice-Chairman of the Naval Consulting Board:

"The work which the American Institute of Mining Engineers has done through its members on the Naval Consulting Board is a patriotic service which is deeply appreciated."

"It has been so valuable that I am tempted to ask that you will request the Institute to enlarge its usefulness to the government still further, by nominating for the approval of the Secretary of the Navy a representative from its membership for each state in the Union to act in conjunction with representatives from the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers, and the American Chemical Society, for the purpose of assisting the Naval Consulting Board in the work of collecting data for use in organizing the manufacturing resources of the country for the public service in case of emergency, I am sure that I may count upon your cordial co-operation."

"With sincere regards, cordially yours,

"WOODROW WILSON."

This letter is so clear and right to the point that no explanation can make it clearer, and little more need be said until definite action is taken in the direction indicated. A representative of each of the National Societies will be appointed for each of the States, and these men will be in touch with the local industries. They will be able to list all industrial plants whose output would be of use in time of war. This would cover not merely actual fighting material, offensive or defensive, but all that goes for sustenance, transportation, etc. The Navy and War Departments will thus be made familiar with the industrial resources of the country, and will know at once where to place orders as they may be required. These plants may always be provided with plans and specifications in advance, and thus may anticipate and provide for national preparedness.

COMPRESSED AIR AND THE RAILROADS

Compressed air has done much for the railroads, and in return it may be said that the railroads have done much for compressed air, while the developments in reciprocal helpfulness are as active as ever. Next to the locomotive itself, the air brake is to the railroad a prime necessity for safe, successful, profitable operation, to say nothing of what air does in the switch and signal service.

The universal adoption of the air brake, and, incidentally with that, the presence of spare air brake pumps, or automatic air compressors, in railroad shops generally, making it easy for railroad men everyvhere to command a ready working supply of compressed air, has induced in railroad men the habit of thinking of compressed air as an ever ready help, not only in times of trouble but more still in everyday work, and has led to the employment of it for many improvised labor saving devices which have successively been generally adopted, not only in the railroad shop but in all the industries, even in those with which primarily the railroads have little to do.

One thing leads to another continually, and the specific employments of compressed air are increasing, perhaps at no time more rapidly than at present. The pneumatic hammer has developed a numerous progeny which has overflowed the shops and now is spreading over the entire field of outdoor engineering. It was, as we may now see, sure in the near future of a job on the track work, the maintenance of way, of the railroad, and the interesting story of its success in this line is now being told. The pneumatic tie tamper has proved an immediate success. It relieves the track workers of their most tiring task and does the work better, quicker, cheaper.

This leads at once to the portable air compressor, and this, too, is now provided. In the smallest size built it is of sufficient capacity to amply supply two tie tampers anywhere, and, being operated by a gasoline engine, it is ready for work at a minute's notice and costs nothing to keep going except when actually at work. The entire apparatus is mounted on a light car which is easily run along the road to points within short hose lengths and can be put on or off the track like the ordinary hand car.

Here again one thing leads to another, or rather to several others, just as any precedent cause is followed by more than one effect. This portable compressor supplies the breath of life not only to the tie tampers but to hammers, drills, grinders that are now often required. Grinding switch points is now a familiar operation, also drilling holes occasionally where a new length of rail is laid, etc. Further developments along these lines may be confidently expected.

SCREW PIPE JOINTS

It is not often that so much which is the reverse of correct is crowded into so short a paragraph as the following, which we clip from an anonymous exchange:

"There are a lot of foolish ideas about pipe dope for threads when screwing the pipe together. It is not the dope that makes the joint tight, but the fact that the pipe is screwed together with a lubricant that will prevent the friction from heating the threads. A good graphite grease is as good as anything and the pipe is always easily unscrewed when graphite is used. Always put the compound in the female thread and not on the male."

It *is* the "dope" that makes the joint tight, and that is what it is used for. If the joint is made without the dope it will certainly leak, and if proper dope is properly applied it will not leak. As to the friction and heating effect of slowly screwing a pipe joint once together, that is nonsense. There is no objection to graphite for the dope. Whatever is used should be placed on the male thread and not in the female. If the latter practice is followed some of the dope will be shoved ahead into the pipe to harden and form an obstruction, slight, perhaps, for a single joint, but something serious on a long line.

A COMPRESSOR EXPLOSION.

A gas engine air-compressor casualty is recorded in the newly issued Factory (British) Inspector's Report, in which two men were killed in Staffordshire by an explosion of an air receiver connected with a power-driven compressor used for the starting of three large gas engines. It appeared that the explosion was due to ignition of a mixture of air and finely-divided lubricating oil. This oil was of high flash-point, specially made for compressors, and the compressor was effectively water cooled, but it had been run for an exceptionally long time, and had probably become hotter than usual. The explosion apparently originated at the point where the discharge pipe joined the compressor, and this pipe was liable to get very hot.

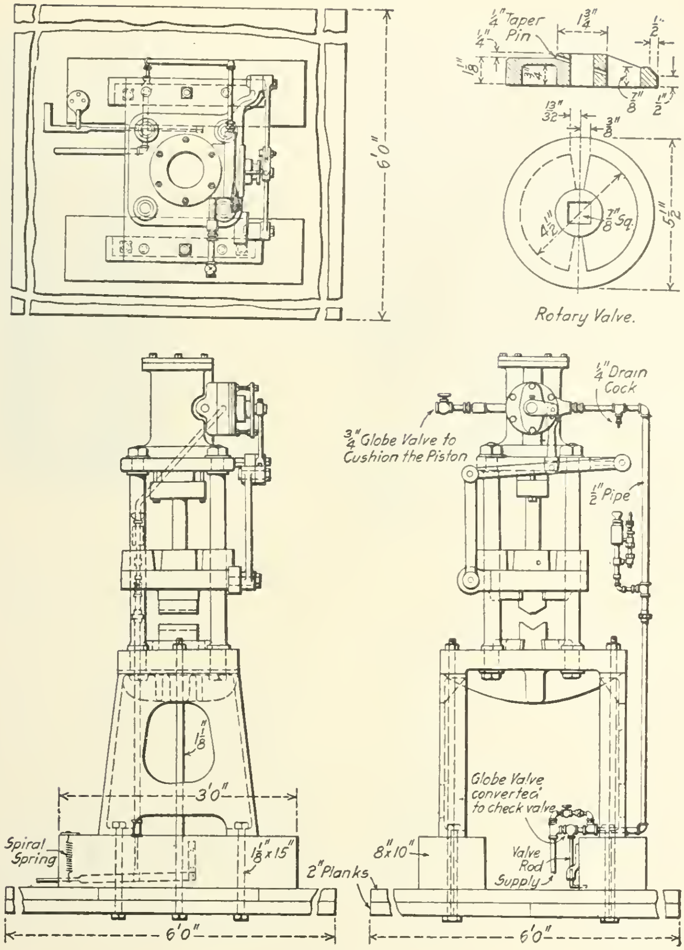


FIG. 2.

A PNEUMATIC BLACKSMITH HAMMER

An ingenious and serviceable air hammer has been devised by William Baird, shop superintendent of the Plattsmouth, Neb., car shops of the Chicago, Burlington & Quincy, for welding bolts and for hammering out scrapped rods to rods of smaller diameter. The photograph Fig. 1 shows one of these hammers located adjacent to a furnace and used for welding bolts. At the base of the hammer, may be seen the two pieces of a bolt before it is welded and a finished bolt. The hammer will make 250 strokes per minute and 650 bolts are welded in an eight-hour day. Bolts from ⅞ in. to 1¼ in. are handled in this machine.

The construction of the machine is shown in the drawing Fig. 2. The cylinder is supported on four columns, 2¼ in. in diameter. These columns are bolted to an anvil block 18 in. by

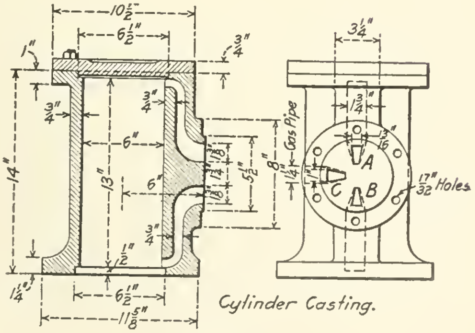


FIG. 3.

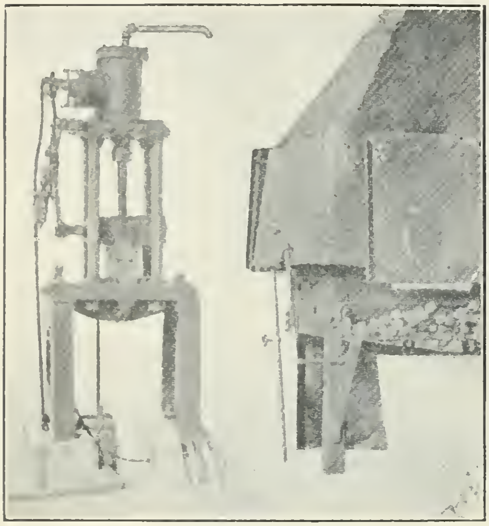


FIG. 1.

28 in. by 3 in. thick, which is reinforced with a 3-in. rib. running lengthwise of the block. This block rests on a cast-iron frame, which in turn is bolted to two blocks, 8 in. by 10 in. These blocks are again bolted to a base 6 ft. square made up of two courses of 2-in. plank.

The cylinder has a bore of 6 in. and provides for a stroke of about 10 in. The piston is 2⅝ in. thick, being designed for three packing rings ⅜ in. thick. The piston rod is 2 ½ in. in diameter and has a taper fit in the hammer. The air supply to the cylinder is regulated by a rotary valve operated by the link motion shown in the side view of the hammer. The valve itself is also shown among the details of the machine. It has one blind and one open chamber which alternately cover the ports *A* and *B*, shown in the side view of the cylinder. The port *C* is the exhaust and is constantly under the blind chamber of the rotary valve. Air is admitted to the cylinder from the valve chest through the open chamber and the ports *A* and *B*. The exhaust pipe is provided with a globe valve for the purpose of restricting the exhaust sufficiently to give a cushioning effect to the piston at the end of the stroke. The air to the valve chest is controlled by a pedal valve at the base of the machine. This valve is by-passed for the purpose of keeping a constant pressure under the hammer, thus holding it in its "up" position when it is not working.

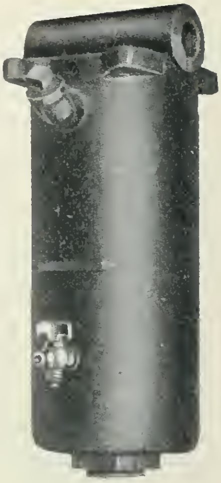
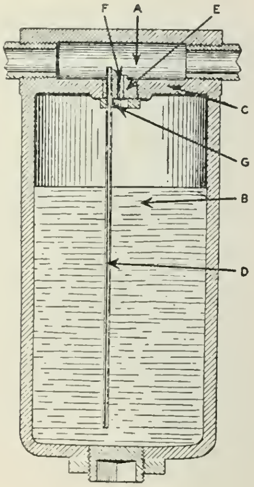


FIG. I.

TO PREVENT THE FREEZING OF AIR BRAKE PIPES

Frozen air brake apparatus is sometimes a serious trouble when atmospheric temperatures run low, and to prevent this the rectifier here shown has been put on the market by the National Safety Device & Manufacturing Company, Chicago. We are informed that it was thoroughly tested in actual service through the winter of 1914-15 with results entirely satisfactory. It not only prevented the freezing but in addition softened the accumulations of grease, gum and oil



within the pipe system in a way beneficial to the working of the valves.

The apparatus consists of a malleable iron body 4½ in. in diameter and 12½ in. long, weighing 19 lb. This is connected into the piping leading from the air storage tanks to the engineer's valve. The air has an unobstructed flow through the passage at the top so that no braking function is interfered with in any way. The freezing is prevented by the automatic mixing of very small amounts of alcohol, or other satisfactory medium, with the normal moisture in the air pipe system, which in addition to raising the temperature lowers the freezing point, thereby preventing the formation of ice particles.

It has been found by experiment that the following alcohol and water mixtures give the freezing points here indicated:

Water, Per Cent	Alcohol, Per Cent	Freezing Point, Deg. Fahr.
100	..	32
80	20	10
70	30	— 5
60	40	—20
50	50	—35

About three pints of alcohol, either grain alcohol or denatured alcohol, which is much cheaper and equally satisfactory, may be placed in the receiver at one time, and this will usually last from three or four weeks to three months.

The action is essentially similar to that of an ordinary atomizer. When the pressure in the pipe line is reduced, say, from 80 to 70 lb., by the operation of the engineer's valve, a minute portion of alcohol is carried into the air brake pipe system.

Referring to Fig. 1, it will be seen that there are two compartments: A, which is an enlargment of the transverse air passage, and B the alcohol reservoir. Communication between the two is through a fine brass tube D securely attached to the brass bushing E. This tube extends from a point about ¼ in. above the bottom of the air passage A to within about ½ in. of the bottom of the reservoir chamber B. In the brass bushing E is an equalizing vent F and an automatic nonreturn valve G. In the fluctuations of pressure which occur in the service pipe the pressure above the body of alcohol is sometimes sufficiently above the pressure in chamber A to allow a little of the alcohol to be carried up and be discharged into the flowing air.

While primarily the device was designed for use during the winter months it may of course remain all the year round, with or without its charge of alcohol. If the supply of alcohol is kept up during the warm months it will improve the braking service by keeping the oil, grease, and gum cut, thus giving a freer valve operation.

MINING ENGINEERS IN THE WAR

An official dispatch from Sir John French, pays the following tribute to the mining engineers, of whom more than 600 are at the front:

"I desire to call your lordship's attention to the splendid work carried out by the tunneling companies. These companies, officered largely by mining engineers, and manned by professional miners, have devoted themselves whole-heartedly to the dangerous work of offensive and defensive mining, a task ever accompanied by great and unseen dangers. It is impossible within the limits of a dispatch to give any just idea of the work of these units, but it will be found, when their history comes to be written, that it will present a story of danger, of heroism, and of difficulties surmounted worthy of the best traditions of the Royal Engineers, under whose general direction their work is carried out."

THE FLOTATION PARADOX

Flotation is a paradox. In a flowing mixture of finely pulverized ore and water it causes the heavy metallic sulphides to float to the surface, where they are collected for further metallurgical treatment, while the light barren gangue sinks to the bottom and is run into the tailing-pond. This apparent reversal of the attraction of gravitation is due to the introduction into the flowing mixture of a small quantity of oil or other emollient in such a manner that every particle of the ore, whether metallic, or gangue, is brought into contact with the oil, whereupon there is what seems a selective action between the oil and the metallic particles such that these become coated with the oil, whereas there is no such action of the oil upon the gangue. Under proper conditions, at or about the same time that this oil coating of the metallic particles takes place, there may be caused to appear in the flowing mixture bubbles of air. These attach themselves to the oil-coated metallic particles and stick to them with more or less tenacity, making a new entity consisting of metallic particle, oil-coating and air-bubble. The specific gravity of this entity is less than that of the water of the flowing mixture; thereupon, because of the attraction of gravitation, and not in spite of it, the heavy metallic sulphides float to the surface and the comparatively light gangue sinks to the bottom, neither oil nor bubbles having any tendency to attach themselves to the barren gangue.—*Dudley H. Norris, in Mining Press.*

PNEUMATIC METHOD FOR MEASURING HIDES

A new German process just patented in this country for measuring the area of hides, makes use of a pneumatic method instead of the mechanical methods which have heretofore been in vogue. It is claimed for the pneumatic process that it is quicker and more accurate than anything that has yet been devised. A table top mounted on a funnel base has many perforations of equal size, placed at regular intervals. A suction fan draws its supply through these holes, and the skin to be measured being placed upon this table, causes a reduction of the air current cross section. Thus a rarification of the air with a resultant measurable sub-pressure is created which serves for a calculation of the area of the hide which is resting on the perforated plate. This figure is indicated by the combined readings of a vacuum gage and the tachometer arranged together at a convenient point over the table.—*Scientific American.*

MINIATURE AIR MOTORS FOR MODEL AEROPLANES

Although miniature motors operated by compressed air are not a novelty in the field of model flying machines, still a new type which has just made its appearance is sufficiently different from the others to command passing comment. It is a five-cylinder rotary type and weighs but four ounces with propeller and mounting frame. On 15 pounds pressure the motor will turn over at 1,000 r. p. m. The bore of the cylinders is 11/32 inch and the stroke 7/16 inch. The "overhand" method is used in mounting the motor on model aeroplanes. With the exception of the valve springs, the entire motor, mounting frame and tank are made of brass.

AIR TO HELP OIL WELLS

Increasing the production of oil wells by forcing air down one of the wells, is being tried in parts of West Virginia. This forces the oil to the adjacent wells. In one case a well that had been making less than a barrel per day was brought up to eight barrels by this method, and other wells have had their production increased 200 or 300%. One objection to the use of this method is that it is a patented process and a comparatively large royalty is required.

NOTES

The new tunnel at Waiahole, Hawaii, which was recently opened, carries 125,000,000 gallons of water daily, and 3,000 acres of cane land will get the benefit of the water supply.

While making more than 16 miles an hour the battleship "Wyoming" recently took on oil from the collier "Cyclops" by means of a pipe extended between the two vessels.

What may be called a pocket blasting machine is being introduced. It will supply current for firing from three to five blasting caps by a sharp twist to its handle. It measures 4½ by 3⅝ by 2⅛ inches and weighs 4½ pounds.

In acetylene lamps for mines, one ounce of good carbide makes about 500 cu. in. of acetylene gas. An ordinary miners' carbide lamp uses nearly half an ounce of carbide per hour, making up to 0.144 cu. ft. of gas.

The lowest barometric reading ever recorded in the United States (*i. e.*, as reduced to sea level and standard gravity) is said to have been that registered at New Orleans during the hurricane of September 29th last, when the pressure fell to 28.11 inches.

Mine timber should have the bark stripped off before being shaped and put in place. By hand a man can peel up to 60 logs per day, but by using a pneumatic hammer with suitable chisel up to 200 per day can be done. When the bark is removed rotting can be detected.

The moving picture industry is using a large amount of silver. There are about 20,000 picture houses in the United States, using approximately 120,000,000 feet of film regularly. The average life of a film is three weeks. It is estimated that 15,000,000 ounces of silver per year—a figure equal to Utah's total production—are used for sensitizing.

Instead of the customary cornerstone setting, a silver rivet was driven, of course by pneumatic hammer, into the steel work of a 26-story building being erected at Madison Avenue and Forty-second Street, New York City, by August Heckscher. When the building is completed the rivet will be exposed in a silver lined recess in the main entrance lobby.

At a cost of at least several million dollars for smelting improvements Anaconda Copper Co. has at last reached a stage in its operations where its net recovery of all metal values in the ore is better than 95%. By the adoption of the flotation process less than 2 lb. of copper per ton is lost as compared with former losses of 10 and 12 lb. In 1913 it cost Anaconda $1.85 per ton to smelt its ore; today the cost is $1.14.

Grouting is now an established method of stopping flows of water in shafts, adits, and drifts. A mixture of cement and water, say a bag of cement to three 12-qt. pails of water, with sometimes a little sand, is forced by a grout-machine into holes drilled in the rock, the pressure being furnished by compressed air. Pressure of 100 to 200 lb. above the hydrostatic head is used in difficult shaft problems. The Nova Scotia Steel & Coal Co., in its iron mine at Bell Island, Newfoundland, where the mine workings are several miles out under the ocean, has a grout-car run on wheels that can force grout into rock at pressures as high as 700 lb. per square inch. By use of this grout-car the workings, although under the Atlantic ocean, are kept fairly free from large flows of water.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents,

DECEMBER 7.

1,162,819. VACUUM FUEL-FEEDING SYSTEM. Harold C. Suckert, New York, N. Y.

1,162,826. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,162,844. PNEUMATIC MILKING-MACHINE. Oscar Anderson, Lancaster, Pa.

1,162,851. FLUID-COMPRESSOR. Edward H. Dewson, New York, N. Y.

1,162,881. SUSPENSION DEVICE FOR FLUID-COMPRESSORS. Walter J. Richards, Milwaukee, Wis.

1,162,884. AIR-COMPRESSOR. Claude Rorabeck, Dayton, Ohio.

1,162,912. WINDMILL. Charles L. Gulley and William L. Mann, St. Joseph, Mo.

1,162,962. ROTARY AIR COMPRESSOR OR PUMP. Edward Wilson, St. Louis, Mo.

1,162,964. ROCK-DRILL. Warren Wood, Paterson, N. J.

1,163,129. AIR-COOLING SYSTEM FOR INTERNAL-COMBUSTION ENGINES. Aurin M. Chase, Syracuse, N. Y.

1,163,161. MILKING - MACHINE. Meredith Leitch, Poughkeepsie, N. Y.

1,163,270-1. METHOD OF IMPREGNATING TIMBER. Grant B. Shipley, Pittsburgh, Pa.

1. The process of treating wood consisting in subjecting the wood to air pressure, and without relieving the air pressure subjecting the same to a bath of a preserving composition under a pressure higher than the air pressure, withdrawing the preserving composition and immediately subjecting the wood to a partial vacuum, thereby extracting a portion of water and composition, and then coating the wood with a waterproofing composition.

1,163,330. FLUID-OPERATED MOTOR. Martin V. B Ethridge, Brooklyn, N. Y.

1,163,419. PNEUMATIC CUSHION. Irving A. Lake, New York, N. Y.

1,163,471. VALVE. Adolph W. Schramm, Riverton, N. J.

4. The combination of a casing connected to a source of air under pressure; a main valve for controlling the flow of air to the casing; a tubular plunger mounted to engage and operate the valve and having a relief opening leading to the outside of the casing; and a valve operable by the plunger for closing communication between the relief opening thereof and the atmosphere before the main valve can be opened.

1,163,543. ROTARY BLOWER. Robert A. Ilg, Chicago, Ill.

DECEMBER 14.

1,163,650. FURNACE-BURNER. George L. Fogler, Pittsburgh, Pa.

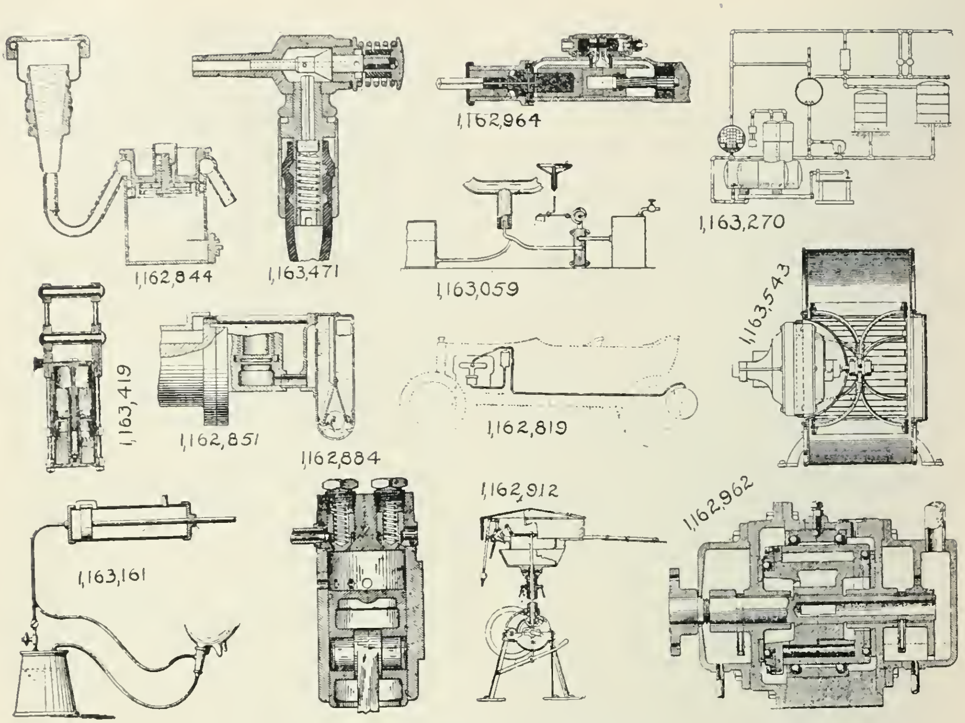
1,163,754. METHOD OF DRAWING GLASS. Halbert K. Hitchcock, Tarentum, Pa.

1,163,768. TUBULAR OZONE-GENATOR. Marius Paul Otto, Paris, France.

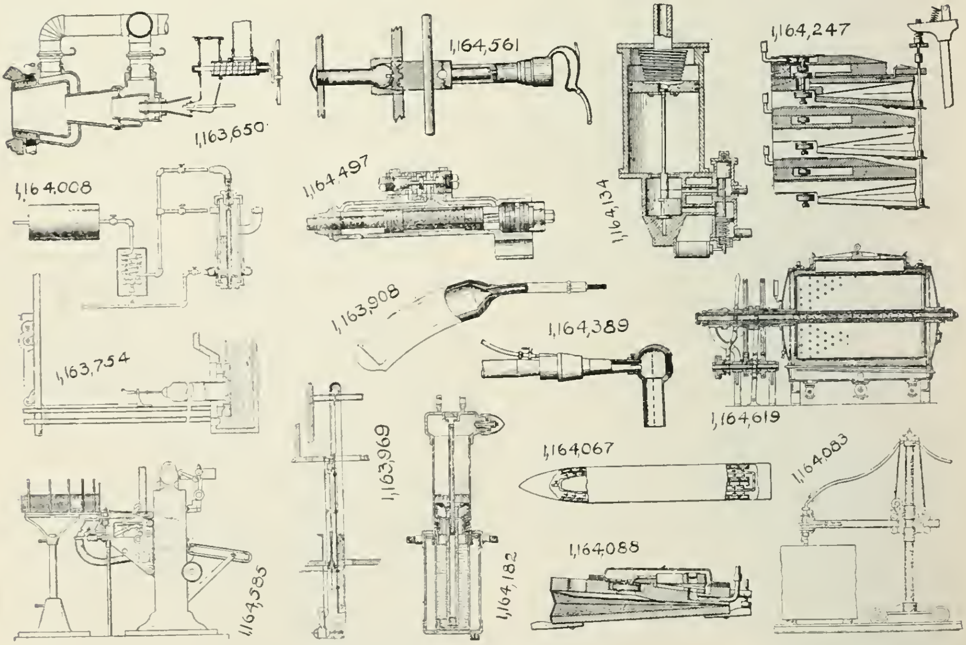
1,163,908. AIR-BAG. Richard T. Griffith, Akron, Ohio.

1,163,969. APPARATUS FOR DRAWING GLASS TUBES, Benjamin Day Chamberlin, Corning, N. Y.

1,164,008. METAL - SPRAYING PROCESS. Ralph W. E. Moore, Swissvale, Pa.



Pneumatic Patents December 7.



Pneumatic Patents December 14.

2. The method of producing a metallic coating which consists in projecting a stream of air or gas at a high velocity into contact with a stream of molten metal, whereby said metal is caused to impinge against a heated deflecting surface and is sub-divided into fine particles which are projected upon the body to be coated.

1,164,067. APPARATUS FOR RAISING SUBMERGED BODIES. Harry Byrns, Hamilton, Ontario, Canada.

1,164,083. STONEWORKING - MACHINE. George H. Gilman, Claremont, N. H.

1,164,088. VALVE-SEAT FOR PNEUMATIC APPARATUS. Adolph P. Gustafson, Chicago, Ill.

1,164,098. VACUUM-VALVE. Samuel A. Kinsey, Jr., Peoria, Ill.

1,164,105. MEANS FOR DEAERATING AND COOLING THE DRIVING MEDIUM OF HYDRAULIC GEARS. Hugo Lentz, Halensee, near Berlin, Germany.

1,164,134. ELECTROPNEUMATIC APPARATUS. Jesse M. Stansell and Charles D. Oland, Centralia, Ill.

1,164,139-40. PROCESS OF ATOMIZING AND BURNING HYDROCARBONS. Charles Vivion Stuart, Memphis, Tenn.

1,164,182. VEHICLE AIR-SPRING. Jonathan S. Green, Pittsburg, Pa.

1,164,247. PNEUMATIC POWER DEVICE. August Young, New York, N. Y.

1,164,389. SAND-BLAST. Edward D. O'Brien, Seattle, Wash.

1,164,496. ROCK-DRILL. George H. Gilman, Claremont, N. H.

1,164,497. PRESSURE-ACTUATED VALVE. George H. Gilman, Claremont, N. H.

1,164,561. PNEUMATIC WRENCH FOR APPLYING AND REMOVING FLUSH CAPS FOR FLEXIBLE STAYS. Charles P. Whelan, Syracuse, N. Y.

1,164,585. PNEUMATIC FEEDER FOR PRESSES. James Duvall, Camas, Wash.

1,164,619. VACUO - CENTRIFUGAL FIBER AND FABRIC TREATING MACHINE. Herbert P. Jefferson, Boston, Mass.

DECEMBER 21.

1,164,632. PNEUMATIC ACTION. Joseph Courville, Detroit, Mich.

1,164,709. EMERGENCY - VALVE ATTACHMENT FOR AIR-BRAKE SYSTEMS. Harry Enoch and George M. Point, Huntington, W. Va.

1,164,758. TRAIN-STOPPING DEVICE. Hiram G. Sedgwick, Mill Valley, Cal.

1,165,024. COMBINED GRAVITY AND FLUID-PRESSURE SANDER FOR LOCOMOTIVES. Edwin A. Rives, Greensboro, N. C.

1,165,040. TANK APPARATUS FOR PNEUMATIC CLEANERS. Albert E. Tolin, Anderson, Ind.

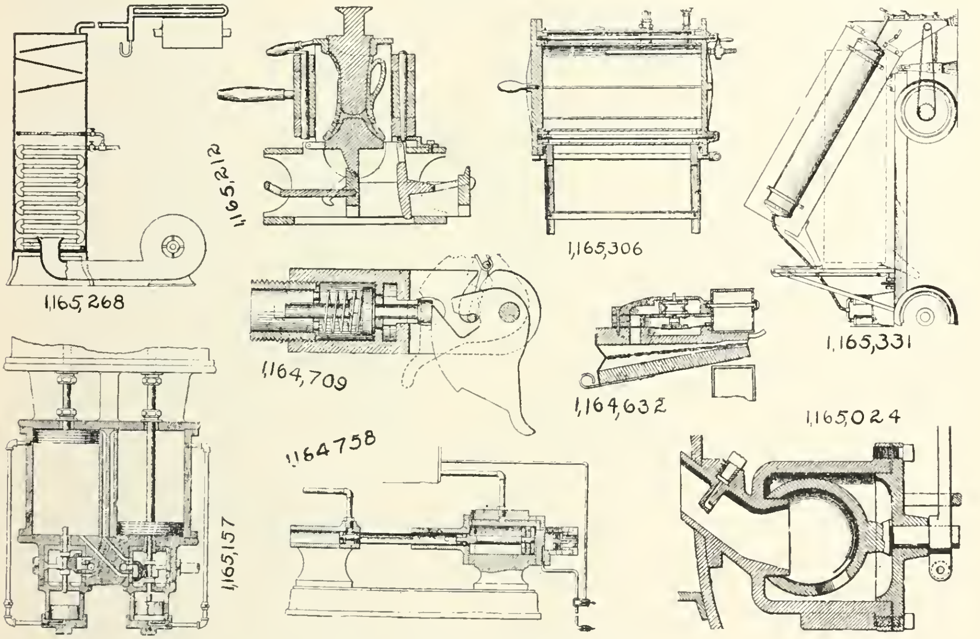
1,165,157. AIR-PUMP. John A. Dreehouse and Fred L. Dreehouse, Laramie, Wyo.

1,165,212. MANUFACTURE OF HOLLOW GLASS ARTICLES. Theodore C. Steimer, Knoxville, Pa.

1,165,268. MOISTENING APPARATUS. Einar Matheson, Woodland, Me.

1,165,306. VACUUM-DRIER. Harry E. Allen and Frank T. Mitchell, Washington, D. C.

1,165,331. ROAD - SANDING APPARATUS. Granville H. Gray, Los Angeles, Cal.



Pneumatic Patents December 21.

DECEMBER 28.

1,165,562. SUCTION-MACHINE. John Wynn, Jr., Canton, Ohio.

1,165,639. ELECTROPNEUMATIC BRAKE APPARATUS. Walter V. Turner, Edgewood, Pa.

1,165,691. PROCESS OF PREPARING HOLES FOR BLASTING. William H. Mason, Easton, Pa.

2. The process of forming a small diameter hole in calcinable rock, applying heat within said hole to the rock to calcine the same, hydrating the calcined material, and flushing it out with water, substantially as set forth.

1,165,715. MEANS FOR CONTROLLING THE QUANTITY AND QUALITY OF THE PRODUCTION OF GAS. John M. Rusby, Philadelphia, Pa.

1,165,794. TURBINE-BLOWER. William Mc Clave, Scranton, Pa.

1,165,826. METHOD OF GENERATING AND CONTROLLING PRESSURE. Edward T. Young, Milton, Mass.

2. A method of operating internal combustion engines which consists in confining air in a combustion chamber heated to a temperature above the temperature of ignition of the fuel whereby said air will be heated sufficiently to ignite fuel, and introducing the fuel into said air in any desired increasing quantity during the first portion of the working stroke of the piston whereby any desired maximum working pressure may be secured and maintained during the introduction of the fuel.

1,165,876. PRESSURE - INDICATING MECHANISM FOR PNEUMATIC-TIRED VEHICLES. Wilber E. Heberling, Youngstown, Ohio.

1,165,901. VENT-VALVE FOR FLUID-RESERVOIRS. Byron S. Randall, Hustisford, Wis.

1,165,931. CENTRIFUGAL FAN OR PUMP. Nicholas W. Akimoff, Philadelphia, Pa.

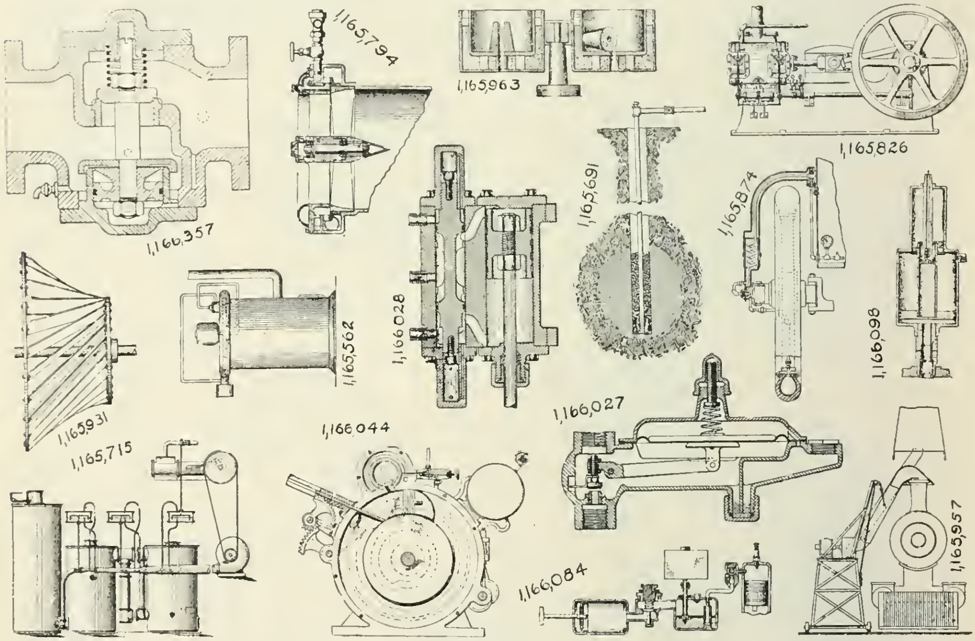
1,166,044. ROTARY FLUID-PRESSURE MOTOR. Francis M. Floyd, Elkville, Ill.

1,166,070. GAGE FOR INDICATING FLUID-PRESSURES. Coleman J. Manning, Medford, Mass.

1,166,084. STARTING DEVICE FOR INTERNAL-COMBUSTION ENGINES. Malcolm P. Ryder, Springfield, Mass.

1,166,098. PUMP. William U. Watson, Chicago, Ill.

1. A compressor having a motor cylinder, a piston, a cylindrically chambered nipple leading to said cylinder for supplying gas thereto, said nipple having a port at the side arranged radially and in a plane transverse to the length of the nipple, and a cylindrical valve sliding in said nipple to cover and uncover said port, said valve having a passage extending longitudinally through it and constricting somewhat the size of the passage in the nipple whereby a gas stream flowing longitudinally through the nipple moves said valve.



Pneumatic Patents December 28.

1,165,957. PORTABLE LOCOMOTIVE-DRAFTING DEVICE. Arthur J. Filkins, Riverside, Ill.

1,165,963. AIR-DUCT FOR GLASS-DRAWING POTS AND METHOD OF LIBERATING AND SETTING THE SAME. Robert L. Frink, Lancaster, Ohio.

1,166,027. PRESSURE-REGULATOR. Edwin C. Weisgerber and Frederick C. Leinroth, Pittsburgh, Pa.

1,166,028. FLUID - MOTOR. Charles Claude Wilkinson, Salem, Ohio.

1,166,040. APPARATUS FOR LINING TUBES. William Burlingham, Newport News, Va.

1. In a percussive tube-lining tool, a pneumatic tool cylinder, a hammering piston within the cylinder, and a plurality of resilient arms supported on said cylinder, the outer extremities of which are externally formed into conoidal segmental surfaces, whereby a compact, spheroidal hammer surface is formed, the inner walls of said arms being shaped so as to coact with the forward end of said piston and be rapidly vibrated thereby.

1,166,125. GLASS-DRAWING MECHANISM. Robert L. Frink, Cleveland, Ohio.

1,166,357. PRESSURE-REDUCING VALVE. John Graham, Glasgow, Scotland.

1,166,358. FLUID-PRESSURE REGULATOR. Patrick Mathew Grant, Chicago, Ill.

1,166,365. PUMP. Charles Taylor Harding, Fayetteville, Ark.

1. The herein described pump mechanism comprising a casing through which water is adapted to circulate, at rotary pump within the casing to cause positive circulation of the water, an air pump within the casing and spaced from the other wall thereof whereby the water circulates around it within the casing, means to operate the rotary pump, and means to cause the air pump to be connected in the same operating mechanism for simultaneous action.

1,166,369. TIRE-SETTING MACHINE. Henry T. Henderson, Keokuk, Iowa.

1,166,407. AIR-BRAKE - HOSE COUPLING. William Ernest Benn, McAdam Junction, New Brunswick, Canada.

1,166,415. PNEUMATIC COUPLING. Aaron J. Tyler, Rochester, N. Y.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

1101

Vol. XXI MARCH, 1916 No. 3

HIGH SPEED AIR COMPRESSORS FOR MINING SERVICE

BY J. M. WALSHE.*

Air compressing machinery appears to be developing along the same lines as the production of electricity, the slow-speed compressor giving place to the high-speed type, with its greater economy of material and space; and, where very large units are required, the turbo-compressor is supplying the need.

In the very large air supply stations on the Rand, turbo-compressor units of a capacity of 20,000, and even 50,000 cu.ft., requiring 4,000 to 13,000 horsepower, are quite a commercial proposition, and have proved a practical success.

Air compressors of this size are, however, very exceptional, and the high-speed reciprocating compressor is quite capable of dealing with the highest outputs so far required in this country; and, in the hands of manufacturers experienced in the design of high-speed steam engines, a very high standard of reliability and efficiency in operation is obtained.

Units of 1,000 to 1,300 hores-power are being successfully worked, and, owing to the relatively high speed of revolution, the weight of the parts and the space taken up are comparatively small. The speed, too, in the case of electrically-operated compressors, assists in keeping down the dimensions of the motor, and permits of the motor being directly connected.

The so-called "high-speed," or, more correctly, "quick revolution" type of compressor is now extensively used in mines and collieries, and any information concerning it should be of general interest.

For the air pressures required for power purposes in mining work, two-stage compression, with an inter-cooler between stages, is the design usually adopted in best practice.

The writer proposes to select as an example of this type of compresor the one with which he is most familiar, and which is probably more largely used than any other, at any rate, in England and the colonies, namely, the double-acting two-cylinder two-crank type, with automatic light plate air valves, and with the working parts lubricated on the forced lubrication principle.

In this type the air valves are placed on the side of the air cylinder, in which position they are readily accessible, and leave the ends free for the water jackets; and, seeing that the compression is mainly done at the ends of the stroke, this is a very desirable arrangement.

In this design it is impossible for oil from the crank chamber to be carried up into the air cylinder, as there is a distance in excess of the full stroke of the compressor between the cylinder and casing stuffing boxes. Another good feature is that piston rods are used, and not trunks. Although the differential trunk is a very usual design, and may be necessary in the case of small single crank compressors, it is one which should be avoided whenever possible. It will be appreciated that a trunk is much more difficult to keep airtight than a piston rod, and that a trunk working in and out of a crank chamber is liable to carry up a great deal of oil, whilst at the same time permitting air to pass down. Apart from the waste of oil, the oil thus carried up may become partly carbonized on the air valves, or distributed throughout the air system, to be detriment of the hose. An even more serious objection is that, if the air becomes heavily charged with oil vapour, dangerous explosions may occur in the air discharge piping or air receiver.

---

*North Staffordshire Institute of Mining and Mechanical Engineers.

In the two-crank design, the circumference for leakage of piston ring and packing is only a quarter of that in the differential trunk design, and, moreover, the difference in pressure on the two sides of the pistons tends to reduce the leakage. For the rest, the forced lubrication system is too well known to need description, but a word may be said concerning the air valves, a most important part of any compressor.

AUTOMATIC AIR VALVES.

In one very efficient valve of this type, the valve seat and valve guard are made of cast iron. In the valve guard are recesses for four closing springs. Next to the seat comes the valve plate, made of thin tempered steel perforated to give a multiple opening. Parts in the slotted plate are ground down and especially tempered to form springs, which enable the valve plate to rise and fall through the small amount of its lift uniformly and without friction. Next above the valve plate is the lift washer, and then the cushion plate, made of thin steel, its function being to soften the blow of the valve plate when lifting.

As the working part of the valve is made of a tempered steel plate only $^1/_{16}$ in. or less thick, it has the advantage of extreme lightness, especially when considered in proportion to its surface area. As the lift is only about equal to the thickness, and the valve plate is guided in a perfectly frictionless manner, it is obvious that it will not be liable to hammer itself or its seat to pieces, and can be depended upon to continue to work for an indefinite period without failure, and without noise.

As previously stated, this type of compressor is especially adapted for direct connection to electric motors. The use of spur or helical gearing between the motor and the compressor should be avoided whenever possible, as (even if the cost of the motor is thereby reduced) the resulting loss of efficiency and possibility of noise and trouble with the gear discount largely any saving in price effected. In the case of motor driven slow-speed compressors, the use of ropes, belts, or other speed reduction gearing is a common practice, and the consequent loss in over-all efficiency is one of the draw-backs inherent to that type of machine.

The intercooler is provided with a central diaphragm plate supporting the tubes at a point mid-way of their length. The air that enters divides on this plate passing four times both upwards and downwards.

The cooling water is also arranged to pass four times upwards and downwards in a direction opposite to the air. The result is a very efficient intercooler, the air usually passing away to the second stage at a lower temperature than that at which the cooling water leaves the intercooler. The tubes and tube plate are of brass, similar in design to the best surface condensers, and can be removed for cleaning. The allowance of cooling surface depends to some extent, of course, on the temperature of the cooling water, but is usually at the rate of 1 sq. ft. for every 4 or 5 cu. ft of free air compressed per minute.

The same design with a strengthened casing makes a very efficient after-cooler. There is a growing tendency, doubtless based on experience gained, to use after-coolers, presumably to improve the quality of the air. A great deal of the moisture in the air is condensed in the after-cooler, and any oil or dirt which may have come through the compressor is also deposited there.

A great point in favour of the adoption of the turbo type of compressor for colliery or mining work is that exhaust steam can be used in the turbine operating the compressor; but it may be pointed out that the exhaust steam can be utilised more economically by coupling the exhaust steam turbine through gearing to a high-speed reciprocating compressor. Such a plant has been in successful operation for three years past at the Glass Houghton Colliery of the Glass Houghton and Castleford Collieries Limited, and has proved a practical and commercial success. Before this novel combination was adopted, the direct driven turbo-compressor received full consideration, but, from estimates received from a large number of makers, both British and Continental, it was apparent that a turbo-compressor capable of dealing with 6,600 cu.ft. of free air, and delivering that quantity at a gauge pressure of 70 lb. per square inch, would require at least 21 per cent. more power to operate it than a reciprocating set.

The efficiency of turbo-compressors may have been improved of late years; mechanically, they are greatly improved, but they are still far from being as efficient as reciprocating compressors of equal output. Moreover, in mining work, where necessarily compressors often run during some portion of the 24 hours at loads much below the full load, the reciprocator possesses still greater advantages, as, for reasons which will be stated later on, the efficiency of turbo-compressors is very low at the lighter loads.

In the plant now in use, the air compressor is of the vertical two-crank double-acting type, suitable for the specified duty when running at a speed of 163 revolutions per minute, and fitted with automatic plate valves of the kind previously described. The turbine is of the mixed pressure type, and the gearing of the double helical type supplied by the Power Plant Company, the bearings being forced lubricated from the system which supplies the turbine. Flexible couplings are fitted on both sides of the gearing. The gearing first supplied was not entirely satisfactory; but, as a result of certain modifications that were made, the initial difficulties were overcome, and the success of the gear drive is now beyond question.

In consequence of the satisfactory performance of this plant, another similar plant of slightly smaller dimensions is now in course of construction, and when the advantages of this combination become more widely known, it is likely to be generally adopted, although for units of considerably larger output the turbo-compressor will hold the field.

EFFICIENCIES.

As is the case with steam turbines, the efficiency of turbo-compressors improves with the size, and for the very large sizes in use on the Rand, the efficiency, if not equal to that of a reciprocating compressor, is still not much below it, and their low first cost is greatly in their favour.

When the performances of compressors are contrasted, the only satisfactory basis of comparison is the over-all efficiency. When a comparison is made between steam-driven compressors running under similar conditions of steam supply and air output, the number of cubic feet of free air compressed per pound of steam consumed is a very convenient figure for the over-all efficiency. The equivalent figure for an electrically-driven compressor is the number of cubic feet of free air compressed per kilowatt input to the motor. These expressions are, however, unsuitable when compressors operating under dissimilar conditions are compared, and it is better to state the over-all efficiency as the ratio of the power available in the air delivered to that supplied to the engine or motor driving the compressor.

There is a natural tendency, on the part of manufacturers whose machines may show a specially good intermediate efficiency, to make the most of that particular feature; but each stage in the process of compression should be equally good, if a high over-all efficiency is to be obtained.

VOLUMETRIC EFFICIENCY.

A high volumetric efficiency, for instance, does not necessarily imply a high efficiency compressor. *As a matter of fact, a low volumetric efficiency may indicate liberal ports and valves, and consequently very small pressure losses in the compressor, resulting in a high over-all efficiency.*

When compressors were bought and sold on the "swept" volume of the air cylinders, and not on the actual quantity of air compressed, the volumetric efficiency was a matter of great importance to the purchaser. Nowadays compressor contracts are unusually based on compressor output, and, provided that the compressor yields its full specified output of air, the volumetric efficiency is of little interest to the user. So long as the purchaser obtains the specified output of air compressed to the required pressure by the consumption of not more than the specified amount of steam or of electrical energy, he need not trouble himself about the volumetric efficiency, or any other of the various "efficiencies" which are so often quoted.

The over-all efficiency of an electrically driven compressor is the ratio of the isothermal horse power in the air discharged to the electrical horse power input to the motor. A good modern direct-coupled, high-speed, motor driven compressor will show an over-all efficiency of from 60 to 65 per cent. The higher over-all efficiency in the case of the electrically driven compressor is explained by the fact that the conversion of electrical energy into work is, in our present state of knowledge, a much more efficient process than the conversion of the heat energy of steam into work.

AIR REGULATION.

The economical working of a compressor is affected to a large extent by the means adopted for controlling the air output. The most economical method is to vary the speed of the compressor in proportion to the demand for air. To effect this an air governor, working in conjunction with a centrifugal speed governor, controls the speed of a steam driven air compressor. For air pressures up to the full working pressure, the compressor is under the control of the centrifugal governor. When the working air pressure is exceeded, the air governor takes control, varying the speed in proportion to the demand for air. It operates in the following manner:—

When the air pressure is below the working pressure, a relay valve is held in its inner position by springs at the end of a lever. In this position the air pressure is shut off from the cylinder, which is open to the atmosphere through the exhaust port, and the speed of the compressor is under the control of the centrifugal governor. Excess air pressure lifts the relay valve against the resistance of the springs, shutting the exhaust port and admitting pressure behind the plunger. The latter moves outwards, depressing the near end of a rocking lever, and raising at the other end the vertical rod attached to the steam throttle valve, thus reducing the supply of steam to the engine. Since the lower ends of the springs are connected to the rocking lever, the movement of that lever increases immediately the tension on them, the relay valve is forced back to a middle position over the cylinder port, and the gear remains stable in the new position. On any further rise in air pressure the operation is repeated, and the steam supply is still further reduced.

A falling air pressure has the reverse effect. The lower air pressure under the relay valve is insufficient to maintain it in the middle position, and under the pressure of the springs it moves inwards, allowing some of the air behind the plunger to escape into the atmosphere. The plunger is thereupon moved inwards by a main control spring relieving the tension on the relay valve springs, and allowing the relay valve to center itself again. With a variation in the air pressure of less than 5 per cent., the range of speed obtainable is about 5 to 1. Without the relay principle embodied in this design the speed control would be intermittent, that is, the compressor would run either at full speed or at the minimum speed. Although a common arrangement, it is not so efficient as the one just described.

Variable speed can also be secured in connection with compressors driven by direct current motors, and to a limited extent in the case of alternating current motors; but, owing to the increased cost of the motor, variable speed is not usual for electrically driven compressors of large size. Automatic stopping and starting devices are occasionally used for the smaller sizes, but, in general, electrically driven compressors are so devised as to run at constant speed.

A common form of unloading device for constant speed compressors is the automatically operated air inlet throttle valve. When the action is intermittent, this is the simplest and most efficient arrangement. When the inlet valve is designed to throttle the air gradually, there is a considerable waste of power at light loads, and the temperature of the air discharged is liable to become excessive.

With an intermittent automatic air inlet valve, under normal conditions the inlet valve is full open, and there is no waste of power due to wire-drawing the air. Excess air pressure shuts the valve completely, and the no load losses are practically confined to the unloaded friction of the compressor. Since no air is being drawn in, there is no churning of the air through the delivery or suction valves.

Where automatic stopping and starting gears are used, the air pressure at the discharge side of the compressor should be released before the motor is started again. This necessitates a non-return valve in the air main close to the compressor, and a relief valve automatically operated by the motor starting gear.

Owing to the inertia of the flywheel and moving parts at full speed, the full load torque is proportional to the mean pressures in the air cylinders; but, when starting, the flywheel effect is absent, and the resistance to rotation is that due to the maximum discharge pressures on the air pistons.

A compressor of a capacity of 450 cu.ft., driven by a 440-volt direct-current motor, recently tested by the author, required about twice the full load current at starting when the motor had to start up with the full air pressure on the compressor outlet valves. When the air pressure at the discharge was released, the starting current fell to less than 50 per cent. of the full load value. Other tests carried out on the same compressor have demonstrated that relief of the pressure at the discharge is much more effective in reducing the starting torque than shutting off the air at the inlet.

TESTING FOR LEAKS.

The maintenance of a high standard of economy involves occasional tests for piston and air valve leakage. When indicators are available internal air leakages can be detected readily by the shape of the diagram, or by comparing the apparent volume of free air drawn in with that shown at the discharge. The temperature and pressure of the air entering and leaving the cylinder must be known in order to calculate the amount of air that is passing.

A standing test will often reveal leakages too small to affect the running intercooler pressure. To carry out a standing test, stop the compressor, leaving it connected to the full air pressure in the receiver, and observe the discharge and intercooler pressure gages. When the air valves are in a good state of adjustment, the pressure in the receiver and the intercooler will remain stationary, or fall only very slowly. Leakage past the second-stage valve will cause the intercooler pressure to rise; on the other hand, leaky first-stage valves will allow the air to escape from the intercooler, and the pressure to fall.

If there are indicator cocks fitted to the cylinders, the leakage can often be traced to the offending valve or valves by opening the cocks in succession, starting at the first stage. When the air valves are in good order, the flow of air from the open cock will be quite feeble, not sufficient to extinguish a candle held in the stream 6 in. from the cock.

AIR SURGING.

Special consideration should be given to the arrangement and preparations of the pipework close to the compressor. Owing to the pulsating motion of the air flow, surges can be set up which affect the efficiency of the compressor. If, for instance, the pipe on the inlet side is of the critical length in proportion to its diameter, air surges will be set up which, if their period synchronises with the beat of the compressor, may become so much intensified as to increase greatly the flow of air into the compressor. The increased volume of the air passing is, of course, accompanied by an increase in the power required, and, when the compressor is electrically driven, this may cause an overload on the motor. In one instance, where the motor operating the compressor was considerably overloaded, it was found that elimination of the inlet pipe resulted in a drop of no less than 40 horse power in the power required to operate the compressor. When the inlet pipe has happened to be of suitable proportions, the air flow has been so stimulated that volumetric efficiencies in excess of 100 per cent. have been demonstrated.

The effect of these surges in the inlet pipe has been found to increase the output by 15.6 per cent., and the power required by 17 per cent. This effect is not, of course, peculiar to high speed compressors; cards showing the same characteristics have been obtained from slow speed compressors. The surge can be eliminated by a considerable increase of the bore of the suction pipe close to the compressor. From 10 to 15 ft. of piping, of an area large enough to reduce the air speed to about 10 ft. per second, is effective in most cases.

The increased output obtained when the air surge occurs on the suction side is some set off for the additional power required; but when the surge is on the discharge side there is no similar compensation, and the extra work due to the surge is wholly wasted. Surges on the discharge side can be greatly minimised by increasing the pipe capacity to the compressor.

These surging effects are naturally of greater importance the lower the delivery pressure is at which the compressor works; and in the case of a compressor operating at a pressure of 5½ lb. per sq. in., such surging effects occurring in the inlet and discharge pipes have been known to increase the power required to operate the compressor by as much as 30 per cent.

It might be supposed that surging effects would be absent in the case of rotary or turbo-compressors, but such compressors are specially liable to be adversely affected in this way. With turbo-compressors, as the output is reduced, a point is reached (generally about five-eighths load) at which the air begins to surge to and fro in the compressor, causing shocks, noisy working, and very high air temperatures. This tendency to surging is responsible sometimes for serious difficulties in running turbo-compressors in parallel delivery into a common main. The remedy usually applied is to keep the output above the critical load by discharging part of the air direct to the atmosphere. To blow the surplus air to waste is undoubtedly the most efficient method of controlling the output, and one that would not be entertained in the case of a reciprocating compressor.

STRAINING ARRANGEMENTS FOR AIR.

It is important—at any rate, if there is much dust about—that some adequate arrangements should be made for filtering the air, and the expense involved in so doing will prove to be amply repaid by the improved results derived from the air compressing plant and tools. At a colliery there is almost invariably a great deal of dust, and in an extreme case it has been found that, not only have the airways into the compressor become choked with a caked composition of coal dust and oil, but that the clearance spaces in the air cylinders have been entirely filled up, causing the compressor to knock. The dirt also accumulates on the valves, thus increasing their weight, and therefore the risk of breakage.

The inter-cooling efficiency is also impaired, with a resulting increase in the air temperatures. Undoubtedly a considerable proportion of the dirt is intercepted in the receiver, but some is certainly carried on into the tools, increasing their wear and tear and liability to derangement. On the whole, there is no doubt whatever that an air filter is a paying proposition. In some cases where it has not been considered advisable to incur the expense of such a filter, the inlet pipe has been removed, and the compressor arranged to draw its air supply from the compressor house, thereby avoiding to some extent the dust; but this course is not advisable, as the noise arising from the air inlet is very unpleasant, to say nothing of the fact that the air is, as a rule, being drawn from the compressor room at a temperature higher than that outside.

The arrangements for filtering the air must be adequate for the purpose. It is useless to set up, as occasionally supplied, a frame of wire gauze very little larger than the air inlet pipe on the compressor. Such a sheet of gauze, if of fine enough mesh to filter the air effectively, very quickly becomes choked with dirt, and may go to pieces and pass into the compressor.

One simple and comparatively inexpensive straining arrangement was developed on the Rand, where there is a vast quantity of dust, and this form has become almost standard in that area. The straining material is of the best cocoanut matting supported by wire netting, and is enclosed in wooden frames, which are so arranged as to form a box, into which the intake pipe of the compressor is introduced.

The frames are secured by bolts and fly-nuts, and are thus easily removable when it becomes necessary to clean them, a spare frame being substituted. Experience has shown that the area of matting should be about 50 to 60 times the sectional area of the inlet pipe. Two strainer houses, each having 32 of these strainer frames, are in use in connection with four high speed compressors, each of a capacity of 6,500 cu.ft., at the New Modderfonteen gold mine on the Rand. The houses stand apart from the main building, and the air is carried into the compressor house by culberts under the floor, into which the inlet pipes of the compressors dip down.

Each of these four compressors is operated by a synchronous motor of 1,000 horse power running at 163 r. p. m. A special characteristic of these compressors is that, influenced doubtless by previous experience, the mining engineer specified the intercoolers should be so designed that the whole of the tubes could be readily lifted out and dropped into a soda tank, in which they might be boiled for the removal of the grease. Reports received after more than two years' operation showed, however, that very little dirt or grease had accumulated.

Although each compressor was fitted with 40 light-plate air valves, 160 in all, none of them had become broken after two years' running. The mining engineer considered that this, as also the cleanliness of the compressors and intercoolers, was attributable largely to the excellence of the arrangements made for cleaning the air, and, further, to the very small quantity of oil used for internal lubrication of the air cylinders. Less than a pint of oil is used in each of these large compressors for a continuous run of 24 hours. About three-quarters of this is used in the air cylinders and the rest in the crank chamber.

In another installation of two electrically driven air compressors, each of a capacity of 1,500 cu.ft., working at a pressure of 100 lb., the air filtering arrangement consists of frames such as described above, with a roof to keep off the rain, the air inlet pipe being carried underground. If necessary, in the interests of the motor, the pressure can be relieved from the discharge pipe before starting up by closing the 6 in. sluice valve and by opening the safety valve, gear being provided for the purpose.

THE BONTEMPI RUST-PROOFING PROCESS

This process, invented by Augusto Bontempi, an Italian chemist, consists in the oxidizing of the surfaces of cast and wrought-iron and steel pieces used in engineering work, thus rendering them able to withstand for a practically unlimited period the corrosive action of the atmosphere, of water, and of sulphurous and other gases.

The pieces to be treated are first cleaned by means of emery-paper or by sand-blasting. They are then placed in a kind of steel-wire cage; this is driven inside an air-tight muffle which has been previously heated by means of gas-jets. When the muffle has been closed in front, after insertion of the pieces to be treated, superheated steam is delivered inside the muffle, with the object of preparing the surfaces of the pieces for the subsequent action of chemical fumes. After the pieces in the muffle have been subjected to the action of the superheated steam for about 30 minutes, the delivery of steam is cut off, and the chemical substance, in the form of a powder, is placed in a separate retort at the back of the muffle. The retort is heated separately, also by gas-jets; the fumes from the chemical powder enter the muffle under pressure, and give the pieces under treatment a protective coating of oxide. On the cage being removed from the muffle, it is covered by a casing, to allow of gradual cooling.

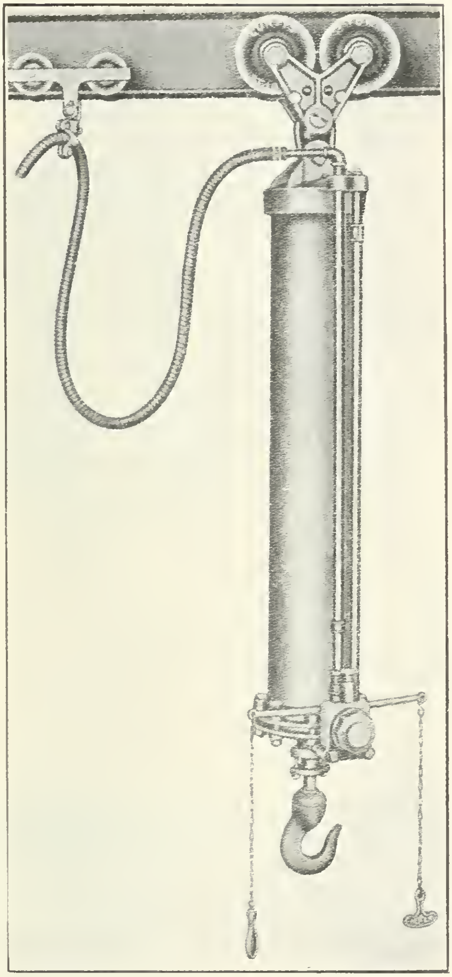


FIG. I. TYPICAL VERTICAL AIR HOIST.

PNEUMATIC HOISTS

There is little or no novelty in the present article. It is a simple account of some of the familiar types of air actuated hoists in use, with some consideration of their advantages or the reverse, and is substantially a reproduction of a portion of an article, "Hoists for Manufacturing Plants," in the February issue of the Engineering Magazine.

The simplest and cheapest type of power hoist is the direct-acting compressed-air lift, Fig. 1. It consists essentially of a vertical cylinder in which a single-acting piston carries a rod projecting through the lower cylinder head by means of a stuffing box. A crane load-hook is attached to the lower end

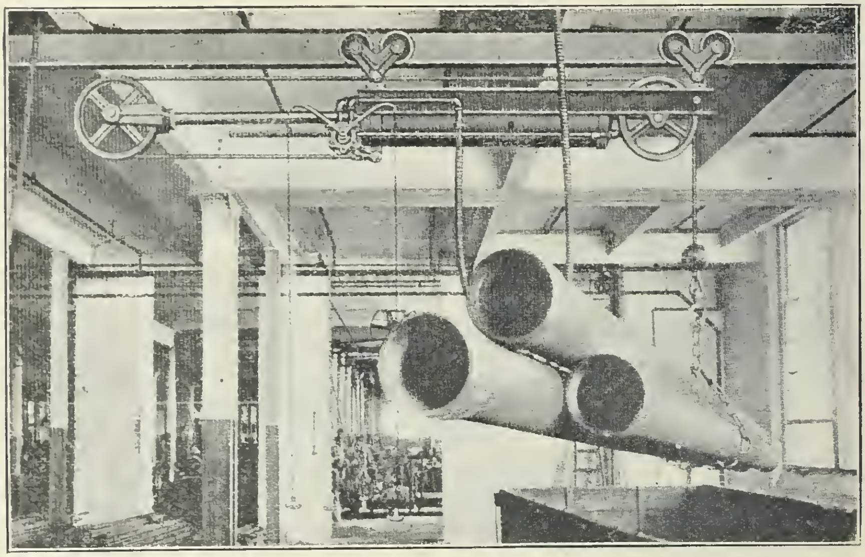


FIG 2. AIR HOIST WITH HORIZONTAL CYLINDER.

of the rod. The valve, which controls the admission of air to the underside of the piston, is operated by a double-ended lever with pendant cords. The inside diameters of the air cylinders vary from 3 to 24 inches in standard hoists, while the stroke varies from 4 to 8 feet. It is obvious that the capacity of a given hoist depends on the air pressure used. With the usual air pressure at 60 to 100 pounds per square inch, the 3-inch hoist will lift from 350 to 600 pounds, while the 24-inch hoist will lift from 24,000 to 40,000 pounds.

This hoist will hold the load in position as

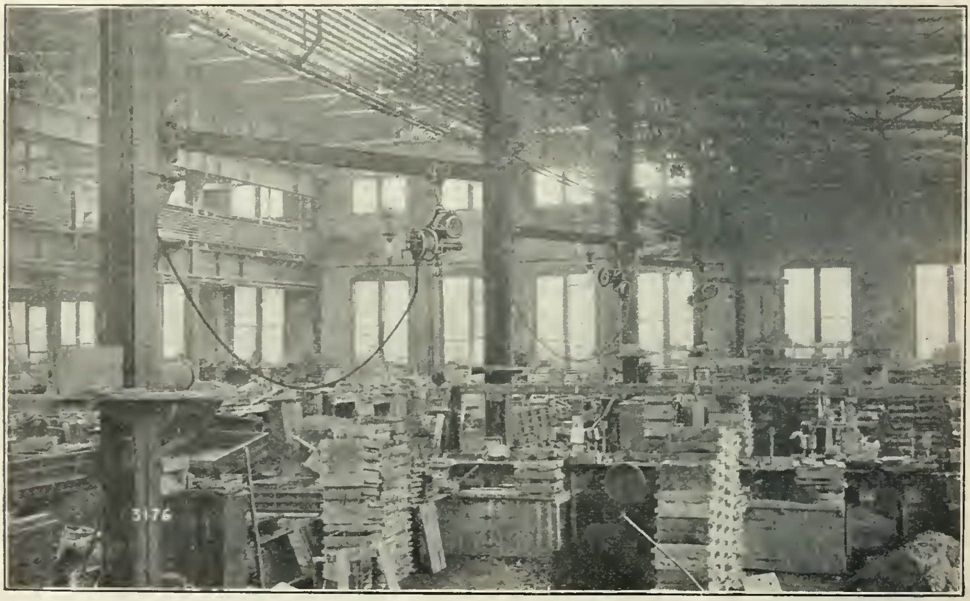


FIG. 3. HOIST WITH MOTOR.

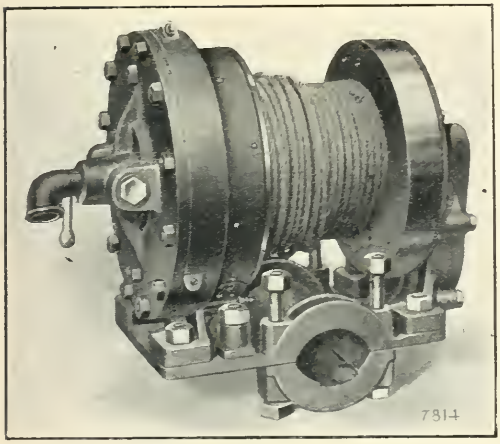


FIG. 4. LEYNER GEARED MOTOR HOIST.

long as there is air at the proper pressure beneath the piston. In order to prevent the load from being dropped because of a broken air hose, a safety check valve is usually fitted on the hoist cylinder.

One of the disadvantages of the direct vertical air hoist is the head room required, and to overcome this difficulty, the cylinder is sometimes placed in a horizontal position and a rope or chain is utilized to get a vertical hook motion, Fig. 2. This type has several other advantages over the direct vertical type. The first is, that the lift may be doubled without increasing the stroke of the piston; another is that the high-pressure air, used for hoisting, acts in the head end of the cylinder and, hence, not on the stuffing box. The hoist must be made double acting, however, in order to force the piston back to the head end of the cylinder when there is no load on the hoist. The pressure required for this operation is small, so there is little stuffing-box trouble.

Another disadvantage of the air hoist is that its range of action is limited by the length of the air hose. This does not prevent a certain amount of mobility, however, and does not make it impossible to use the hoist on a short-travel trolley.

To overcome some of the disadvantages of the direct-acting hoist, the hoist illustrated in Fig. 3, has been designed by the Ingersoll-Rand Company. The power unit is a three-cylinder reciprocating engine, or motor, such as is used on pneumatic drills and reamers. The crank is stationary, and the cylinders revolve. Air admission and exhaust is controlled by ports in the stationary crank, thereby eliminating valves. The motor is geared to the hoist drum by means of a worm and worm-wheel in the small sizes; a pair of spur gears is added in the larger sizes. As in the hand-operated screw hoists, there is no brake needed to hold the load in any position. The operating valve is of the reversing type, so the motor may be run in either direction, and is so arranged that it will close automatically when the pendant operating cords are released. There is also an automatic stop which closes the valve when the load has been raised to the top. This hoist is built in the five sizes shown by the table below.

A type of motor similar in results to the above is shown in Fig. 4, and in action in Fig.

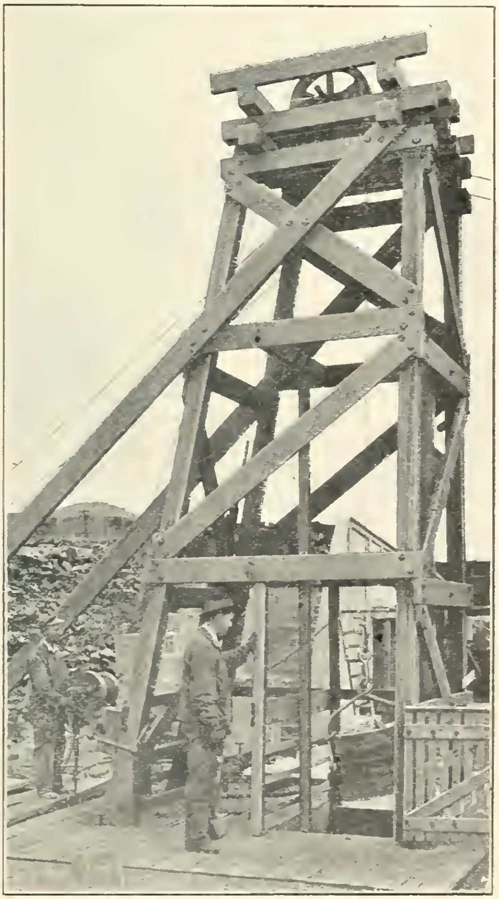


FIG. 5. LEYNER HOIST IN SHAFT SINKING.

5. It has a considerable range of lift and is used for light shaft or well sinking and for general "knock-about" service. As will be seen, it is entirely enclosed and self-contained, is lubricated by a splash system, and is built with the idea that it will be used by inexperienced operators and under the severest conditions. The capacity is 1,000 pounds, with a rope speed of 85 feet per minute with air at 80 pounds pressure. The drum has a capacity of 700 feet of ¼-inch or 450 feet of $^5/_{16}$-inch rope.

SUCCESS OF LIQUID AIR IN BLASTING

We have to confess that we have had little expectation that liquid air could ever be successfully used for mine blasting, for the simple reason, if for no other, that it evaporates so rapidly. The following written by a correspondent of The Engineering and Mining Journal, seems to give a very authoritative and convincing story of actual success with it, with a probability of permanent employment.

The use of liquid air as an explosive has been known ever since the famous Professor Linde took out the first patent in 1895. It was used in the building of the Simplon Tunnel, and has been tried in a number of countries, notably France. But until very recently it was regarded as still in the experimental stage. Immediately upon the outbreak of the war it was put into practical operation throughout the German mining industry. The results have proved so successful that it is now certain that it will continue to be used in place of dynamite even after the war.

In the first place it is peculiarly safe. You can take a cartridge—as they call the little black mouselike bags—put it into the bucket of liquid air which, literally, steams with cold, until the cartridge has soaked up 90 gr. of it, and then, with the assurance that you are dealing with an explosive more than half again as powerful as the ordinary charge of dynamite, you can put it down and step on it, and the only result is a fizz as of so much steam. I saw five of these cartridges jammed with a stick into the holes drilled in the rock just as if they had been so many wet rags. And then I saw the men running like mad when the electric current was turned on and the pieces of rock began to fly.

The cheapness is another advantage. Over against 20 pfennigs, the approximate cost of a dynamite cartridge, one cartridge saturated with liquid air costs, at this Rammelsberg mine, only 12 pfennigs. And where it is made in larger quantities, the cost is even less. A whole new industry is in the process of development in Germany to manufacture and handle liquid air; and the principal firm, the Marsit Corporation, declares the cost of liquid air to be just one-half that of dynamite.

DRILL STEEL AND ITS TREATMENT

The following by E. M. Weston, Johannesburg, South Africa, here reproduced in abstract from The Engineering and Mining Journal, Dec. 18, has to do with tests conducted by the Mines Trial Committee during 1910-11. While they should be of interest to mining engineers in all parts of the world they have never before been published. It is much to be regrettted that the work was all done by hand, and that nothing was apparently known of the excellent work now done by the Leyner drill sharpener, which suggests that a supplementary paper should follow this.

The alloy steels referred to are steels containing chromium, banadium or tungsten, and perhaps aluminum, while the carbon steels are the ordinary steels with manganese and a little aluminum.

When heated steel is hardened by plunging it into cold water it is often too hard and brittle. This defect is diminished and the steel is made tougher at the expense of hardness by heating it to some temperature 200°—300° C. for a short time. This operation is generally necessary in the case of high carbon steels, but with ordinary steels of lower carbon content it can be dispensed with by quenching in hot water.

CRITICAL TEMPERATURES.

On heating a piece of rock drill steel slowly and observing its rate of rise of temperature with a pyrometer, a halt will be observed to occur between 700° and 750° C., denoted by the sign *A*c. On slowly cooling a similar halt is observed, usually 30° C. below *A*c, and this is denoted by *A*r. The halt at *A*c is due to the expenditure of heat in producing microscopical structural changes, the steel being converted into mortensite. This structure is retained if the steel is suddenly cooled, and the steel is hardened.

If the steel is cooled slowly it becomes soft, or is annealed, owing to the change of the mortensite into pearlite and ferrite when the steel contains less than 0.9% carbon, or into pearlite and cementite when carbon exceeds 0.9%. Ferrite is very soft, pure iron. Cementite is hard, brittle carbide of iron. Pearlite is a mixture of the two. The points *Ac and Ae* are called the recalescent or critical points of steel.

THE TESTS.

The steels tested were 1½ in. cruciform, 1 in. and ⅞ in. octagon, and were used in 2¾ in. stoping drills. They were given the necessary heat treatment, and the bits were measured, inspected and weighed before and after being used. The distance drilled was noted and sometimes the drilling speed. Various marks were allotted for merit, and the question of price also was considered. Chemical analyses were made of the various steels, and a fair idea of the class of steel most suitable for work in the hard quartzites of the Rand, and inferentially in hard ground elsewhere, was attained.

First, with regard to loss of reaming efficiency with ⅞ in. octagon drill steel, a comparison of the steels giving the best and the worst results showed.

For the Best		For the Worst	
Carbon	0.800%	Carbon	0.640
Silicon	0.070%	Silicon	0.180
Sulphur	0.012%	Sulphur	0.020
Phosphorus	0.029%	Phosphorus	0.032
Manganese	0.270%	Manganese	0.430

This showed lower carbon content and greater sulphur and manganese in the poorer steels.

With regard to loss of weight through wear, the results showed:

For the Best		For the Worst	
Carbon	0.770%	Carbon	0.650
Silicon	0.110%	Silicon	0.100
Sulphur	0.010%	Sulphur	0.020
Phosphorus	0.029%	Phosphorus	0.026
Manganese	0.290%	Manganese	0.380

This shows a similar result, and the bad effect of phosphorus.

The general results of the tests were:

A. Although some of the alloy steels have shown excellent drilling results and are not costly in steel consumption, not one of them is equal to the rest of the ordinary carbon steels. With alloy steels a uniform composition is harder to obtain than with carbon steels. The former have more tendency to overheat and are more difficult to weld.

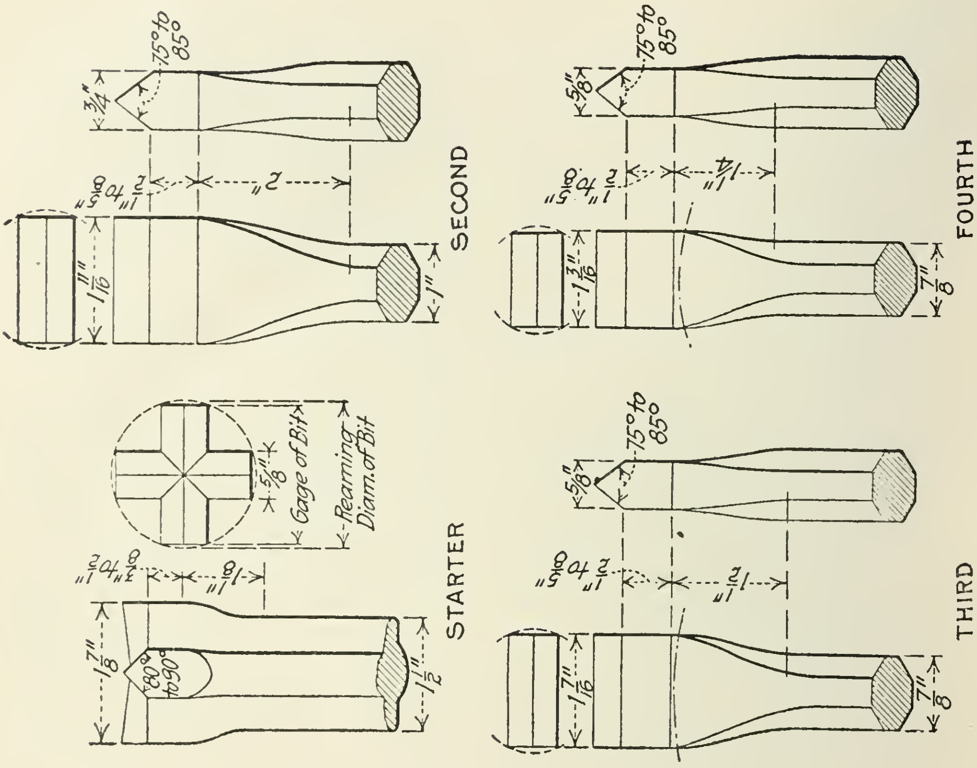
B. Best 1½ in. cruciform steel: Steel having carbon content above 0.75% was rejected, owing to the difficulty of welding it. It was also found that, as a general rule, the larger the size of steel the lower should be the carbon content, as the difficulty of equal or regular heating and quenching increases with the size of the steel. The best steels of this size had a composition: Carbon, 0.66% silicon, 0.09%; sulphur and phosphorus, 0.036%; manganese, 0.28%.

C. Of the 1-in. octagon steel the best had a composition of: Carbon, 0.69%; silicon, 0.09%; sulphur and phosphorus, 0.036%; manganese, 0.30%. Of the ⅞-in. octagon steel the best had a composition of: Carbon, 0.72%; silicon, 0.09%; sulphur and phosphorus, 0.035%; manganese, 0.27%.

Bits made from sections larger than 1½-in. cruciform are much larger, and in rapid working they tend to overheat if the interior is properly treated, thereby decarbonizing; quenching is also difficult. These steels should contain from 0.60% to 0.65% C. In all these steels the maker should be allowed to use aluminum as a purifier if not more than 0.10% is left in the finished steel. The best steels were Swedish bessemer, crucible, open-hearth (mostly) and electric crucible. Steels were found to improve after being sharpened several times, probably owing to the effect of hammering on the grain of the steel.

PARTICULARS OF THE HEAT-TREATMENT.

Usually, on the Rand, all drills except those of hollow steel are heated but once for a long distance from the bit. They are rapidly sharpened, they are not gaged and are quenched without reheating. This method tends to over-heating, to the decarbonization



TYPES OF BITS USED.

of the steel and to irregularities in the gage. The steels of the compositions already quoted can be quenced off the anvil without tempering. The temperature of the quenching bath should be between 18° and 26° C. Drills should be properly cleaned and should be slowly heated. Hand steel requires 5 min., medium steel 8 min. and large steel 12 min. This heating should preferably be done in an oil furnace, as overheating is very liable to occur with coal fires, especially when watched by natives. The drills should be heated to a bright orange red heat (about 1,050 C.) for 1½ in. for hand steel, 2 in. for medium sizes, 3 in. for large steel, and be thoroughly and regularly heated through the mass of the steel. The heated drill should be forged until it cools to a dull-red color, about 600° C. With hand sharpening, this should take from 45 to 60 sec. The bit should be at once reheated to a bright-red color, about 950° C. It should then be finally sharpened and carefully gaged until a cherry red color, about 750° C. This should take another 45 sec. Bits of 1½ in. cruciform steel, or larger are quenched by standing them on a knife edge ½ in. or ⅝ in. below the surface of the water. Smaller bits are plunged vertically, moved about for a few seconds and left standing on a false bottom. With more rapid machine sharpening, except with hollow steel, one heat should be sufficient, as gaging is automatically done.

Quenching tanks should be supplied with cold water at the bottom at three places and should have a false bottom, as well as frame and knife-edge below water level. They should be fitted with an indicating thermo-telegraph thermometer, so that the necessary temperatures can be maintained. Usually the bath is allowed to be too cold in the morning and to get far too hot later in the day. If steel is quenched at above 800° C., the grain gets coarser, the tensile stress and the elongation both become less. The higher the carbon contents of the steel, the higher should be the temperature of the water for quenching. If, however, it requires a higher water temperature than 35° C., the carbon content is too high for rock drills unless tempering is employed. Shanks of drills may be tempered by leaving them for a minute in a molten-lead tank 1 in. deep, covered with ashes; if somewhat harder shanks are required, a little tin may be added to the lead.

The loss of weight per inch drilled with the very best steel was 0.4 gram, and good steel averaged about 0.6 gram, costing about 0.015 penny. The total cost of solid steels and its sharpening is 6% of stoping costs of 4s. to 6s. per ton. With hollow steel it is about twice as much. The best steel could be bought in Johannesburg at from 4d. to 4½d. per lb. The loss of steel per inch drilled was found to be the same with all three sizes of steel experimented with.

DESIGN OF DRILL BITS ADOPTED.

The style of drill bits adopted has been already illustrated in the *Journal*, but it deserves further notice.

It was stated that chisel bits were found by experiment to be the fastest drillers and this was claimed to be due to the facts that they occupy only 50 to 63% of the hole and that they allow the escape of mud better. This reason is open to question. The four square reaming edges, of the depth shown in the sketch, were adopted. I have seen such a design of bit recommended for hammer drills, but it is opposed to all accepted theories of the correct formation of the wings of piston-drilled bits. One might suppose that it would prejudice the rotation of the drill in the hole, but the fact remains that the experimenter got most excellent results in hard ground from this design, and I commend it to the attention of mining engineers elsewhere. The next point of interest was that the experimenter showed that by using gaged steel, more carefully sharpened, and drilling larger holes, it was possible to reduce the drills used per fathom broken from 35.8 to 26.6. Gaging may take 25 to 30% more time and add to the cost of sharpening, but it pays for itself. The reaming diameter of the holes drilled was greater than the nominal gage. The experimenter says of these square reaming edges: They should be hardened for ¾ of their length. (1) They help by reaming out the hole to keep it from decreasing in diameter too rapidly. (2) They prevent "wobbling" of the drill in the hole and thus preserve its cutting edge and reduce wear and tear on machine. (3) The drill passes slips or heads better.

The thickness of the bit should be kept about ⅝ in., otherwise the reaming diameter is increased too much. There was a great difference in gage used; 3/16 in., ¼ in., and ¼ in., as shown by the following table:

The experimenter remarks that it would be possible to reduce the gage. This is evident. Owing to vibration of the drill in the hole, the hole bored is always 0.05 larger than the bit, so that all the difference necessary between different steels would have been about ⅙ in., or 0.17 in. This would have meant an increase of drilling speed equivalent to starting the hole at about 1⅝ in. instead of 1⅞, probably 10 to 15%. This is a matter that received far too little attention, owing to the mistake of using the same steel to drill dry holes as to drill wet holes.

Another series of experiments showed the benefit of gaging steel. The ordinary run of mine steel was found when new to differ from 0.09 in. to as much as 0.17 in. from the proper gage, while the gaged steel hand-sharpened was found to differ only between 0.01 and 0.03 in. from standard.

These experiments undoubtedly were most valuable and pointed out the way to a great increase in efficiency in stoping on the Rand. Yet, except in the case of perhaps one or two mines, the results have received no attention whatever. Machine drills are, when sharpened by hand, as badly sharpened as ever, though the quality of the supply of drill steel itself has been standardized very well.

CARE OF PNEUMATIC TOOLS*

BY AUGUST MEITZ.

In handling pneumatic tools several points are to be taken into consideration. First of all, it is a good policy to adopt a standard of such tools on any one railroad system. This plan would reduce the cost of repairs and maintenance about 50 per cent. as well as reduce the expense for repair parts to be carried in stock in order to expedite repairs and to prevent holding tools out.

In selecting pneumatic tools for service a great many mistakes are made as regards to speed and power. For instance, an air motor of high speed will be used by a boiler maker to drill out stay-bolts; and as soon as he has completed this drilling, he will use the same motor for running in a stay-bolt tap, say $1^1/_{16}$ in., thereby using the same speed as he had just used on a $^{13}/_{16}$-in. high-speed drill. In such cases damage is often done to the motor as well as to the tap—the motor is overloaded and the tap is overspeeded, with the result that the motor will break in some place and the tap is spoiled. The same result is had by drilling and reaming at too high speed on the motor—the reamer is spoiled. Taking the standard rule, "What is gained in speed is lost in power," we come to the conclusion that it is unwise to have all high-speed motors in any one shop, as the little time gained by drilling is a double loss in spoiled drills and taps which, if handled in a more reasonable manner, would pay for the lost time.

---

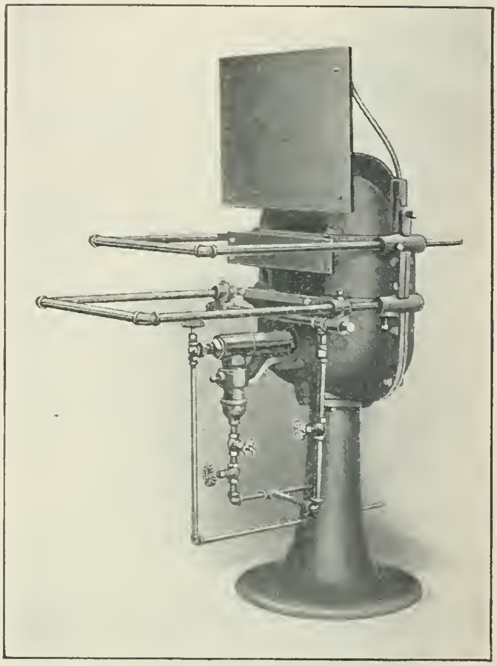
*Proceedings American Railway Tool Foremen's Association.

All motors should be kept clean and well oiled at all times. Good engine oil should be used, and it will also be found to pay to use some light grease to fill the case or crank chambers.

Air hammers should always be well oiled before using. A light mineral oil, we have found, gives best results. Any oil which will gum or thicken in cold weather should be avoided. After a hammer has been in service and returns to the toolroom, it should be placed in a solution of gasoline and signal oil, equal parts, as small particles of rubber from the hose lining frequently lodge in the chamber between the handle and the throttle-valve sleeve. The gasoline mixture will cut this rubber, and by blowing out the hammer with compressed air, all refuse and foreign substances are removed. After the hammer has lain in the oil about five minutes, it should be taken out and hung up to drip. Before the hammer is used again, all parts should be properly oiled.

Others find that if air hammers are kept in a coal-oil bath when not in use, there is very little repair work to be done on these tools until some part becomes worn so that it must be replaced by a new one.

The throttle handle of the motor is filled with coal or signal oil every evening, which prevents throttle valves from sticking and also keeps the valves of the machine clean.



LEYNER OIL FURNACE WITH PREHEATING FEATURE

The No. 3 Leyner oil burning furnace, here shown in the halftone, which is used extensively for heating drill steel, is now made with a preheating chamber which greatly increases the capacity of the furnace. The preheater portion fits between the body and cover of the furnace of the old design and it is a simple matter to attach this section to an old furnace by changing a few bolts. The lower chamber is used for the final heating and the upper one for preheating.

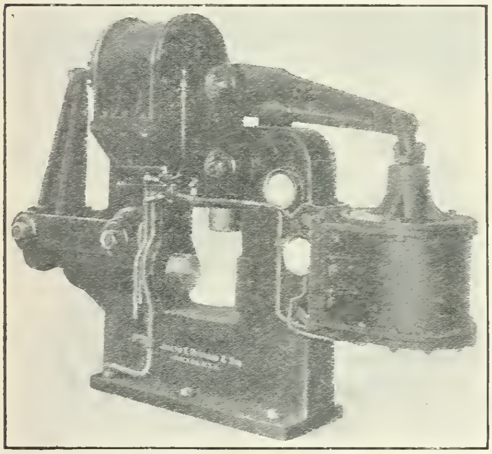
It is claimed that by the addition of the preheating feature, the space for heating is doubled, the heating capacity of the furnace is increased about 50 per cent. and the efficiency of the furnace is increased correspondingly. The steel also is heated more slowly.

The type of burner now furnished with this furnace is suitable for either high or low pressure air. It has merely to be throttled for high pressures, and when this is done, it is as efficient as burners designed especially for high pressures and eliminates the noise common to such burners.

This furnace burns petroleum or any of its oils, such as gasoline, kerosene, distillate, etc.

Oil heating has many advantages. The steel cannot be injured by absorbing injurious elements such as sulphur, phosphorus, or other impurities which are present in nearly all coals, nor from unequal heating, as the steel is heated in a flame which gives a uniform temperature. The steel is in full view of the operator at all times. The absence of smoke, soot, dust, ashes and cinders is a great convenience, particularly appreciated in underground mine installations and in plants installed in buildings. The floor space occupied by the No. 3 furnace is 3 by 4 feet. No foundation is required, installation being complete when the air and the oil supply pipes are connected.

Made by the Ingersoll-Rand Company, 11 Broadway, New York.



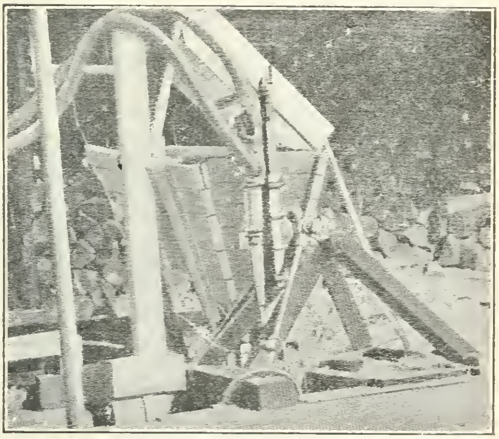
PNEUMATIC SPRING BANDING PRESS

The halftone above shows a heavy press for closing the centre bands upon standard leaf springs for railroad service, a recent addition to the machinery line of Joseph T. Ryerson & Sons, Chicago. As will be seen there are two plungers, horizontal and vertical, actuated through powerful leverage from two 16 in. air cylinders. The movements and the ultimate pressure, which may go as high as 60 tons, are controlled by three-way valves connected with each cylinder. The ordinary shop supply air pressure is sufficient, and, on account of the infrequency of action, the air consumption is small. The machine weighs 6,500 lb.

FOR BETTER TUNNEL PHOTOGRAPHS

Tunnel photos usually taken by or for contractors, as records of progress and for other purposes, are generally more or less unsatisfactory on account of the lighting conditions. Ordinary flashlights give only local illumination and the distant portions included in the view are not clearly defined. A tunnel photo of unusual detail and clearness was taken under the direction of Mr. S. P. Brown, chief engineer of the Mount Royal Tunnel & Terminal Company, Montreal.

When taking the picture after the camera had been set and the lens uncovered, a man with a magnesium blow-torch mounted in front of a large screen was ordered to walk through the tunnel in front of and away from the camera, thus illuminating the bore for a long distance without any of the direct rays fogging the plate. This seems to be an excellent scheme, where it is possible to use it.



AN ELECTRIC-AIR-DRILL STAMP MILL

Many a mine superintendent has felt the need of a more thorough method of prospecting orebodies he is opening than by the assaying and panning of marked samples, before it is advisable to build even a small mill of the regular type. This need has been met by the South Fork Gold Mining Co., at Forest, Sierra county, California, in the following manner. The company had purchased a Temple-Ingersoll electric air-drill, for the purpose of extending the hard-rock tunnel for gravel, and did 400 ft. of work along that line. Since then attention has been given to developing one of the lodes where the rock is not hard or solid enough to stand a power-drill. The drill not being in use, it was thought that it could be made serviceable as a one-stamp mill; on account of the heavy blow that it strikes and because of the low cost of operation, it has answered the purpose exceptionally well. Working in this capacity, the drill uses 2½ hp. and crushes a ton of hard quartz through a No. 1 screen in 14 hours, striking 220 times per minute with the motor operating at half-speed, which is not the regulation rate, but the motor does not show any ill effect of continuously running at half speed. The drill is mounted on a tripod that in turn is held by heavy timbers, which are anchored to the solid rock. —*Mining Press.*

THE NOISE OF A BULLET

A person in the line of fire of a modern gun hears distinctly two successive detonations. According to his distance these may be close together or farther apart, and they may or may not be accompanied by a continued whistling or roaring sound. The two noises, as is noted by Col. Agnus, of the French army, in the *Revue Scientifique* (Paris), are familiar to target-keepers in rifle matches, who usually suppose them to be caused respectively by the discharge of the gun and the impact of the bullet on the target or the ground. This is incorrect. Col. Agnus tells us that the first noise is the discharge, but the second is due to disturbance of the air by the bullet. When the projectile starts, it is moving faster than sound. It slows down, and when it has gone about a mile and a half the sound-wave begins to gain on it and finally passes it. To these facts are due the phenomena of the bullet's noise, as is shown by Col. Agnus in a mathematical analysis. In the first place, the two noises will be heard only with modern high-powered weapons, whose bullets move faster than sound. If the observer is nearer than about 300 feet the two sounds merge into one. Farther away they are heard farther and farther apart, and at about a mile and a half, the point where the velocity slows down to that of sound, a continuous whistle or roar is heard, first between the two detonations and farther away, lasting longer and longer. Of course, if the projectile is a shell, its subsequent explosion adds other noises.

GIVING DRILL-STEEL A REST

BY CARROLL M. CARTER

Steel experiments, at the Carter Mining Co., Ohio City, Colo., proved of great service in reducing breakage to a minimum. It came about in this way: We were short of steel and noticed that the breakage seemed to be more than usual just at a time when we could stand it least. Acting on this hint, we took a new piece of steel, put a Leyner shank and bit on it and sent it into the mine to start a drill hole. Immediately after the hole was started, the bit was brought out and resharpened and sent in to start another hole. This process was kept up until the steel jumped in two when starting the 12th hole. Another piece of steel handled in the same manner, but in somewhat softer rock, started 16 holes before breaking. Then another new piece of steel was sent in to start a hole and afterward allowed to lie idle for three days, when it started another hole. Four pieces of steel were used in these experiments, and by being permitted to rest as stated, they started, averaging the four, 51 holes each before breaking. We now have on hand three times the amount of steel needed in any one day and use one-third of it every third day and have next to no breakage.—*Eng. and Min. Journal*

A RAILROAD DITCHER AND GRADER

The Bowman ditcher and grader, shown in the accompanying halftones, is rigged for four kinds of work on railroad lines: excavating side ditches, plowing hard material, spreading dumped material and dressing the slopes of cuts. The apparatus it carries is duplicated and identical on both sides of the car so that it works on either or both sides of the track, as may be required. All operations on the machine are controlled by compressed air which is stored in large vertical receivers charged to 100 lb. pressure by three air brake pumps. As the ditcher is always accompanied by a locomotive it supplies the steam required.

The 50 ft. flat steel car carries two steel gallows-frames each supporting two jet cranes with 4 yd. scraper buckets suspended by a bail with operating chains running to two vertical air cylinders. The larger cylinder, 24 by 60 in., operates the hoisting chains, while the smaller cylinder, 12 by 60 in., operates

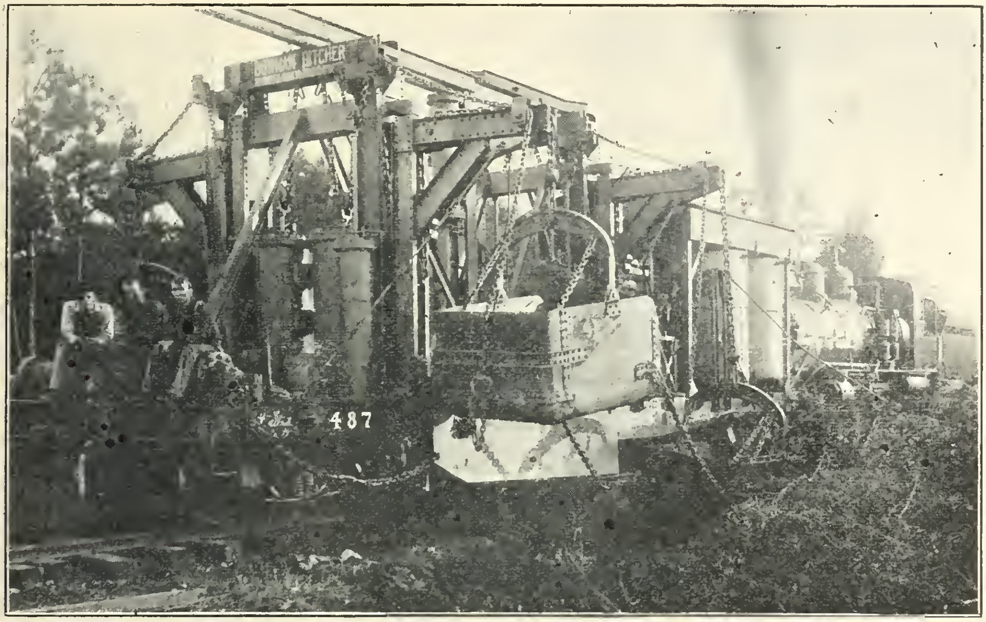


FIG. I.

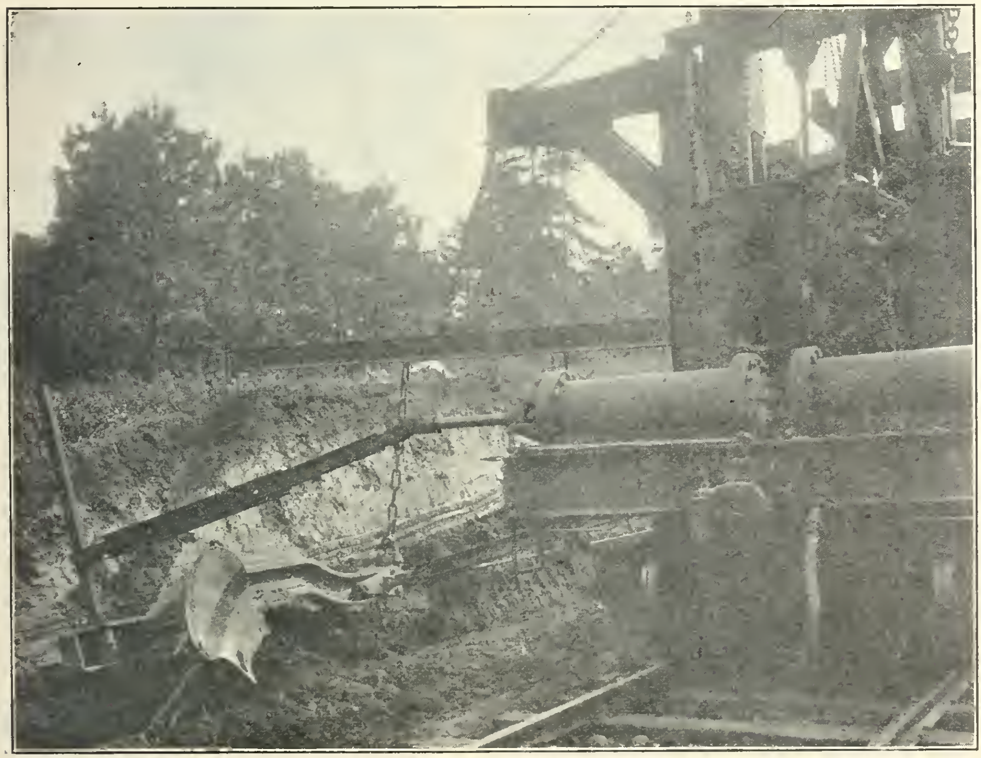


FIG. 2.

the dumping chain attached to the rear of the buckets. With the machine in place for ditching, as in Fig. 1, the forward bucket on each side is lowered and the locomotive pulls ahead slowly. When the buckets are loaded, taking in soft material about 5 cu. yd. each, they are swung up and the rear buckets are lowered and loaded in the same way. The machine is then hauled to the dumping ground and returned at once to load up again.

For spreading material dumped along the track on fills or in yards there is a scraper blade hinged to the side of the car, as seen under the rear bucket in Fig. 1. Where the material is too hard for excavating directly by the buckets, or where hard material is to be loosened for widening the roadbed beyond the reach of the bucket, the machine handles a heavy plow, as seen in Fig. 2. This plow is raised or lowered by a side tipping movement, the lever connecting with the piston rod of the horizontal air cylinder on the rear of the car.

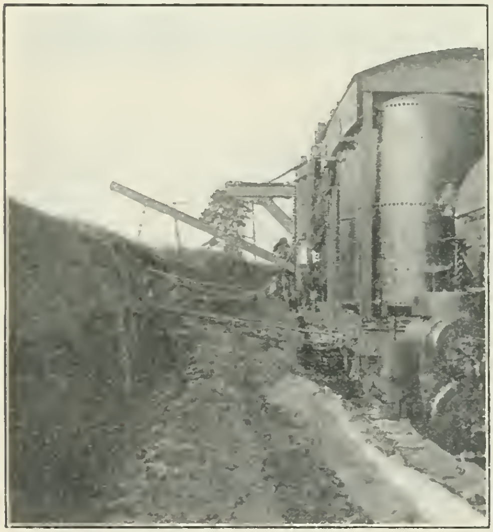


FIG. 3.

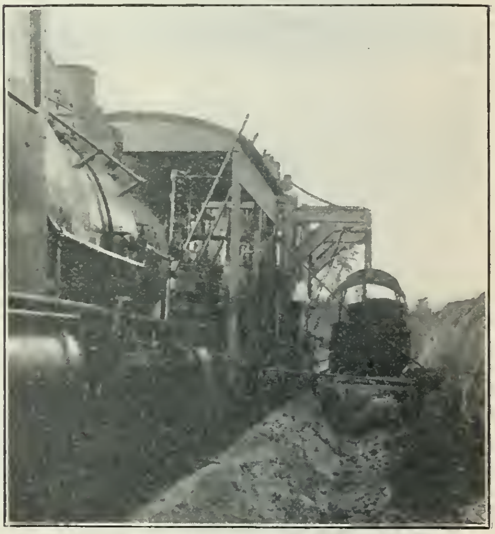


FIG. 4.

For dressing slopes or widening cuts there is a scraper attached to a pair of telescoping struts, as shown in Fig. 3. The scraper is also used to form a shoulder for the ballast.

Fig. 4 is a view of the suspended buckets from the front.

The machine requires a crew of three men besides those on the locomotive. It has been used continuously as here shown with complete satisfaction on the Norfolk Southern R. R. Machines of this make have been used also by the Southern Pacific Co. and the Missouri, Kansas & Texas Ry. with uniformly good results. On the Southern Pacific the ditcher in a single month handled 22,320 cu. yd., in 8,650 ft. of ditch, at a cost of about 6½c. per yard., to which was added 3½c. per yd. for the work of shifting signals and cattle guards, dressing the ballast and trimming the ditches, and carrying them away from the ends of the cuts. In 18 months this machine averaged 8,720 cu. yd. per month, at a cost of 15c. per yd., 20c. including repairs and the miscellaneous work mentioned above.

The last machine of this type built for the Norfolk & Southern operated in the month of November, 1915, over a length of 75 miles cleaning out and widening shallow cuts and distributing material, which entailed a great many different moves. The average yardage per day was 486; average distance hauled 1,886 ft.; average cost per yard, 7.6c. Maximum yardage for a single day, 912.

The ditcher was invented by Benjamin Bowman, Springfield, Mo., and is sold by the T. W. Snow Construction Company, Ellsworth Building Chicago.

A TUNNEL RECORD IN THE COURTS

J. A. McIlwee & Sons, engineers and tunnel contractors have received a verdict for $800,000 against the Canadian Pacific railroad in the court of appeals of the Dominion of Canada. The railroad has taken the case to the law lords of the English privy council (which is the court of last resorts in the British empire), but it is certain that the law lords will uphold the decision of the court of appeals and that McIlwee & Sons will collect.

The facts are that, Dec. 18, 1913, McIlwee & Sons entered into a contract with the railroad to drive a five-mile railroad tunnel through the Selkirk mountains in British Columbia. In addition to the price for the work, the Canadian Pacific agreed to pay the contractors a bonus of $1,000 for every foot of the tunnel bored each month, from each end, in excess of 900 feet. The formation in that part of the Selkirk was known to be very difficult, and it did not seem probable that McIlwee & Sons would be able to earn a cent of that bonus. It was, indeed, doubted whether they could live up to their contract in the matter of the maximum time allowed for finishing the job.

But McIlwee & Sons, instead of falling down on their contract, worked so far ahead of it in the rapidity of their bore, that, in nine months' time, the Canadian Pacific railroad owed them $215,000 for bonuses. The contractors had, in fact, maintained their minimum of 900 feet a month from each end of the tunnel and 215 feet in addition.

However, when the Canadian Pacific railroad realized that McIlwee & Sons seemed likely to pile up about $1,000,000 in bonuses, it started raising all kinds of artificial difficulties to retard the work. In spite of these difficulties, McIlwee & Sons kept on with the work, earning more bonuses all the time. Then, as a last resort and in order to save themselves the payment of the bonuses, the Canadian Pacific raised some fictitious quarrel and canceled the contract. Forthwith McIlwee & Sons filed suit against the Canadian Pacific in the supreme court of British Columbia for breach of contract and for the bonuses then due. They were awarded $527,000.

The Canadian Pacific appealed the decision and award to the court of appeals of the dominion. That court not only upheld the award in favor of McIlwee & Sons, but increased it to $800,000.—*Mining American.*

LIMITS OF WORKING TEMPERATURE IN MINES

In the report of the Royal Commission on Mining Industry at Broken Hill, (Australia), a section is devoted to the question of the possibility of the reduction of temperature to 75 degs. Fahr., or, if this should prove impracticable, a reduction in the hours of work in proportion to the temperature. The Commission considered the question of what constitutes a high temperature. In Queensland, a Royal Commission had previously recommended a degree of humidity represented by a dry bulb temperature of 85 degs. Fahr. and 80 degs. Fahr. wet bulb. If the dry bulb temperature exceeds 85 degs. Fahr., the wet bulb must be at least 7 degs. less. In Western Australia the standard is 87 degs. Fahr. dry and 80 degs. Fahr. wet. In Victoria 83 degs. Fahr. wet bulb, and in New Zealand 80 degs. Fahr. wet bulb. In Great Britain the Royal Commission on Mines, 1909, refused to fix a standard, but Dr. Haldane has stated that for the economical working of a mine the wet bulb temperature should not be allowed to rise above 81 degs. Fahr., unless perhaps where there is a good ventilation current. The present report discusses the various causes of high temperatures in mines, which are due to:—(1) The progressive increase of temperature with depth; (2) the oxidation of minerals; (3) the warming influence of men, animals and lights; (4) explosives; (5) the incoming air during the summer months; (6) rise of temperature due to increased barometric pressure, amounting to 1 deg. Fahr. in 180 ft. It appears that in New South Wales there is a seasonal variation of underground temperature amounting to 3 degs. Fahr., but this would probably be overcome by improved ventilation. The hot places in a mine are always the dead ends, and it generally happens that the hottest places are those in which it is necessary to use water to keep down the dust, which keeps the air moist and raises the wet bulb temperature. The Commission has come to the conclusion that a standard should be fixed of 82 degs. Fahr., wet bulb, but a minority report recommends 78 degs. Fahr. wet bulb.

AN UNUSUAL AIR LIFT INSTALLATION

The interesting air lift plant here to be described has been installed for supplying the Transcontinental Railway yards at the Quebec Bridge. The neighborhood of the magnificent St. Lawrence would seem to be an anomalous location, but several considerations operated to determine the installation. The rise and fall of the tide, the height of the embankment and the unsuitability of the river water were important points, and besides this the use of the river water would have necessitated the construction of a pumping plant at a distance from the power house, and would have increased the cost of attendance.

Work was started in September, 1912. Forty-three feet of 8 in. wrought iron pipe was driven from the surface to the rock, and from that point a 5-in. bore hole was started. The well was drilled entirely in shale, red and gray alternating.

On September 30th a depth of 400 ft. had been reached, and a rough pumping test yielded 200 imp. gal. per hour. At 280, 520 and 700 ft., respectively, dry crevices were encountered, while at 775 feet water was struck in considerable quantity. The hole was then reamed to a diameter of 8-in., and a subsequent test yielded 3,200 imp. gal. per hour.

At a depth of 980 ft. another water crevice was opened up and at a depth of 1,012 ft. drilling was discontinued. The whole well was then reamed out to 8-in. diameter. A large plunger pump was used for a 24-hour test, and with 400 ft. of rods in the well a yield of 5,400 imp. gal. per hour was maintained. This pump was afterwards operated for eight days to clean out the well, and a sample of water was analyzed and reported satisfactory for both boiler and domestic purposes.

When the well is not being pumped water rises to the surface; when being pumped to capacity it drops, however, to a depth of 400 ft. from the surface.

A joint contract was awarded to Canadian Ingersoll-Rand Co., Limited, and Williams and Wilson, Limited, of Montreal, for furnishing and installing a suitable pumping plant. The air-lift system was adopted owing to its numerous advantages over other systems of deep-well pumping, as with this system there are no moving or wearing parts in the water, and the air-compressor may be located at any distance from the well.

In lowering the pipes and foot-piece, which were extra heavy, great care was required because of the weight; but there was no mishap of any kind.

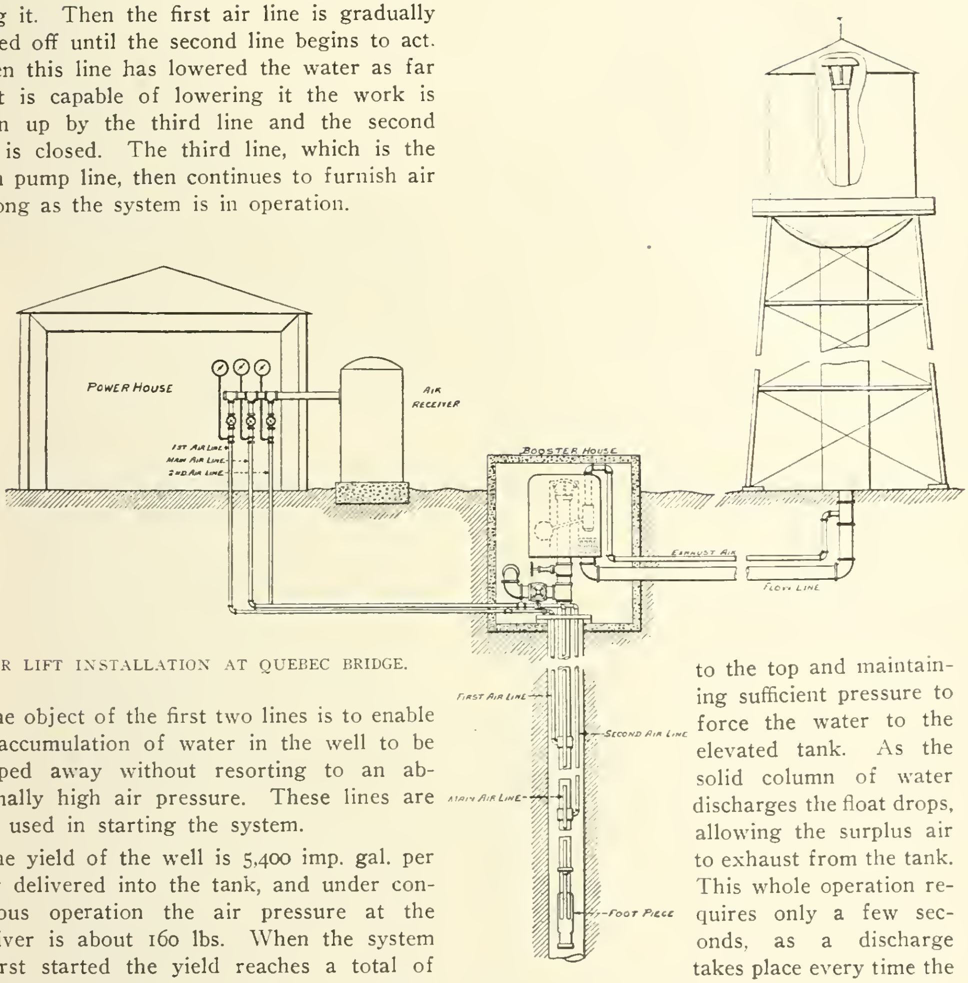
The air-compressor is a Canadian Ingersoll-Rand tandem compound steam-driven machine, designed for a terminal pressure of 250 pounds, and the air cylinders are fitted with a new type of valve known as the circo-leaf valve, which is absolutely noiseless in operation. The frame is fully enclosed, and the moving parts work in a constant flood of oil. A combined speed and pressure governor controls the compressor.

The air-lift foot-piece was manufactured by the Harris Air Pump Co., of Indianapolis, whose pumps are extensively installed throughout Canada. The column of water is carried by an air-jet situated below a choker, which arrangement eliminates slippage and causes the air to be distributed through the water in small bubbles. The booster pump was also furnished by the same firm.

Water is discharged into a steel tank 24 ft. in diameter, and the total capacity, including the leg, is 61,170 imp. gal. The level of the water in feet is indicated by a marker on the outside of the tank, and by this means it is possible to accurately gauge the capacity of the plant. The tank is supported by a steel frame resting on a concrete base, in which are located the valves and connections to the service mains and to the main drain. Steam is furnished to the compressor at 110 lbs. pressure.

Owing to the depth to which the water drops in the well three air lines are used, two being tapped into the water discharge line at different depths, and the third entering the Harris foot-piece. Each of these three air lines is controlled by a gate-valve in the power-house, and the engineer operates the system without going near the well, which is 250 ft. from the power-house. A gauge over each line shows the pressure and indicates the fall of the water in the well.

Air discharges from the compressor into a high-pressure air-receiver and from there to the well. The first air line starts the water flowing and continues to pump until the well lowers as far as this line is capable of lowering it. Then the first air line is gradually turned off until the second line begins to act. When this line has lowered the water as far as it is capable of lowering it the work is taken up by the third line and the second line is closed. The third line, which is the main pump line, then continues to furnish air as long as the system is in operation.



AIR LIFT INSTALLATION AT QUEBEC BRIDGE.

The object of the first two lines is to enable the accumulation of water in the well to be pumped away without resorting to an abnormally high air pressure. These lines are only used in starting the system.

The yield of the well is 5,400 imp. gal. per hour delivered into the tank, and under continuous operation the air pressure at the receiver is about 160 lbs. When the system is first started the yield reaches a total of about 6,000 imp. gal. per hour, this being due to the accumulation of water filling the well to the surface. The yield gradually decreases under continuous operation until the normal capacity and pumping head are reached.

At the surface the water has to be pumped horizontally a distance of 60 ft., and subsequently to a height of 90 ft. into the top of the steel tank. For this work a Harris booster operates in conjunction with the air-lift.

This booster consists of a steel tank resting on the top of the well-casing and receiving the water as it discharges from the well. The operating parts consist of a float and valve located inside the tank. The water and air are separated in this tank, the air rising to the top and maintaining sufficient pressure to force the water to the elevated tank. As the solid column of water discharges the float drops, allowing the surplus air to exhaust from the tank. This whole operation requires only a few seconds, as a discharge takes place every time the booster is about two-thirds full. In fact, practically a constant flow is maintained.

The surplus air may be piped back to the compressor intake or discharged into the vertical riser to lighten the column of water and reduce the operating pressure. This latter plan was followed in the case of the plant at Quebec. The booster is automatic in operation and requires no attention. It also operates without noise. This apparatus is located in a concrete sump below the ground and is reached through a door in the roof. A by-pass is connected to the main drain so that the well can be pumped directly into the sewer for cleaning purposes.

The plant was operated by the contractor for several days under the supervision of

Mr. Alex. Porter, Assistant Engineer of the Transcontinental Railway, who at the completion of the test said the plant was entirely satisfactory, and the most reliable of the various railway divisional pumping units.

The high lift in this case is a noticeable feature, amounting to about 500 ft. vertical and 60 ft. horizontal. It demonstrates as far as it goes that there is practically no limit to the height to which the air lift will raise water if a fair amount of submergence is obtainable.

On a test recently the plant pumped nearly 6,000 gal. (Temp.) per hr., but this capacity was due to accumulated water near the well. The normal capacity (5,000 gal. per hr.) was developed continuously after the level dropped to 400 ft. At this point the running pressure was 160 lb. per sq. in. The highest pressure required for starting was 225 lb.

TURBO-BLOWERS AND TURBO-COMPRESSORS*

Basically considered, turbo-blowers and turbo-compressors are similar machines, only that the former are used for low pressures and the latter for high pressures. Both classes of machines are therefore constructively different with reference to the number of stages and the delivery volume. Usually the turbo-blowers and compressors of today are built on the principle of the centrifugal pump—that is, the gas to be compressed is conducted in radial paths. Among the few designs that depart from this arrangement is the Parsons, in which the flow direction, as in steam turbines, is axial.

It is difficult to define the boundary between turbo-blowers and turbo-compressors. All turbo machines used to supplant reciprocating blowers should be called turbo-blowers.

The pressures vary between 0.3 and 3 atmospheres, according as the blower is used for blast furnaces or for bessemer converters. Under normal operation blast-furnace bloweres are run under 0.3 to 0.75 atmosphere: at times double that, and the delivery volume varies greatly; while in the case of the converter blast the pressure is about 3 atmospheres and the delivery volume is approximately constant.

The capacities of turbo-blowers for blast furnaces run from 1,000,000 to 3,500,000 cu.ft. an hr., steelworks having a lower figure, or up to about 1,750,000 cu.ft. per hr. Turbo-compressors have, in general, a lower capacity, say up to 1,250,000 cu.ft. per hr., but must thus attain considerably higher pressures, 6 to 10 atmospheres. Occasionally higher capacities are reached, as in the case of three turbo-compressors recently built by the Allgemeine Elektricitäts Gesellschaft, each of which has a capacity of a little less than 3,000,000 cu.ft. of air per hr. compressed to 8 atmospheres.

In the choice of a driving medium it must be kept in mind what is to be expected of the blower or compressor in the way of regulation of the capacity and pressure. In general it can be said that where great capacity fluctuations obtain, as in the case of blast-furnace blowers, the preference is for the steam turbine, whereas with constant capacity the high-speed electric motor is used. In relatively small plants the steam turbine is used almost exclusively, as with the fixed-speed electric motor. Under such circumstances the number of stages can be kept down and thus decidedly affect the design, as the construction cost is almost proportional to the number of stages.

Essentially the design of the Allgemeine Elektricitäts Gesellschaft turbo-blowers and turbo-compressors is a series of consecutively placed bucket wheels, the number depending on the desired final pressure and the kind of gas to be compressed. It varies between 1 and 26, up to 14 being usually on one shaft, and where a greater number is called for two compressors are arranged in tandem.

Notwithstanding the water-cooled housing of the turbo-machines, the temperature rise of the gas from, say, 70 deg. F. can extend to 212 deg. Although in the later stages this phenomenon is much less in evidence, to the end that the compression finally is even closely isothermic, the total thermal efficiency is nevertheless injuriously affected thereby; so that in this respect the turbo-compressor has not so far come up to the reciprocating one.

As a general conclusion it can be said that in the first stages the cooling effect is not

Continued on page 7931.

---

*O. H. Wunderlich in *"Zeitscrift des Vereines deutscher Ingenieure."*

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE
Compressed Air Magazine Company
Easton, Pa.
New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. MARCH, 1916. No. 3

CONTENTS

High Speed Compressors for Mines.... 7907
Bontempi Rust-Proofing Process....... 7913
Pneumatic Hoists...................... 7913
Liquid Air in Blasting................ 7916
Drill Steel and its Treatment......... 7916
Care of Pneumatic Tools............... 7919
Leyner Oil Furnace.................... 7920
Pneumatic Spring Banding Press...... 7921
Electric-Air-Drill Stamp Mill.......... 7921
Noise of a Bullet...................... 7922
Giving Drill Steel a Rest.............. 7922
Railroad Ditcher and Grader.......... 7922
Tunnel Record in the Courts.......... 7925
Working Temperatures in Mines....... 7925
Unusual Air Lift Installation.......... 7926
Turbo-Blowers and Compressors....... 7928
Compressed Air May Save a Park...... 7929
Status of Natural Gas Compressors.... 7931
Air in Compression and Expansion.... 7932
Tempering Mine Drills................ 7934
Notes 7935
Patents 7935

COMPRESSED AIR MAY SAVE A PARK

The public parks of New York, and especially the smaller or neighborhood parks, are among its most valued possessions, and permanent encroachment upon or curtailment of them invariably provokes popular protest. At the present time a large pumping station for the New York City aqueduct of the new Catskill system is being erected upon a small lawn which is an important feature of Morningside Park, constituting a great disfigurement and a practical destruction of an attractive section of this valued resting place, and and much popular indignation is expressed.

As to the urgent and immediate necessity for this pumping station there can be no question. When water has been admitted to the new aqueduct, and it has been subjected to the full service pressure, it will be necessary to shut off the pressure and to pump out the water, so that the aqueduct may be examined from the interior for the detection of leaks or weaknesses or imperfections of any kind. After two or three such pumpings-out, if the aqueduct was decided to be in satisfactory condition, the services of the pump might not be required again for many years, but it would be necessary to maintain it constantly ready for immediate use in case a break in the aqueduct should occur, or any accident requiring the unwatering of the tube.

On the Croton aqueducts, either the old or the new, there was no requirement for any such unwatering plant, because the lines were carried so high that they could all be drained by gravity. The one exception to this was the siphon of the new aqueduct which passes under the Harlem River at a great depth, and for the unwatering of this a permanent installation was provided and is maintained in constant readiness, although it has not been called upon in a score of years. In the first arrangement for this service there was an enormous bucket to be successively raised and lowered in the shaft, but this was replaced by a return-air pumping apparatus which will do the work in half the time.

Now, as to the Morningside Park pumping station here under discussion, it happens that just in this neighborhood is the lowest spot in this section of the city aqueduct, so that the precise location selected may be presumably the best, and the pumping devices decided upon also may promise the most satisfactory results, all of course without thinking at all of any outside conditions. When these assert themselves and call for a compromise in the arrangements, it cannot be denied that there are other ways of doing this thing which would be less objectionable, and these should at least be carefully considered.

This matter is being variously discussed in current issues of the daily press. The following is from an interview with W. L. Saunders, retiring President of the American Institute of Mining Engineers, in the New York Times, Feb. 13, 1916:

I hesitate, said he, to speak for publication on this matter, because I have a high regard for the Engineer in Chief of the Board of Water Supply, and I have no doubt he has given this question much study. From the point of view of absolute economy and efficiency the Board of Water Supply may have much on its side. Are there not other considerations, however, in a question of this kind? There are aesthetic reasons why the matter should be discussed from a new angle. The putting of a structure forty feet high in Morningside Park is not justified. All citizens should interest themselves in seeing that it is not done. I never look at that unsightly pile, the Post Office Building, without thinking how public spirit years ago might have saved a large part of City Hall Park. The Board of Water Supply has a shaft in Morningside Park and proposes to establish a pump there for drawing the water out of a portion of the tunnel in case of emergency. Tunnels like this are often unwatered for repairs. There are several ways of doing this, as the Board of Water Supply itself has admitted, such as forcing the water out with compressed air, using automatic bailing devices, employing pumps in separate shafts, using mine sinking pumps, and lastly the device which was adopted by the board's engineers, a pumping equipment on a float with which the water could be followed down the shaft. The board adopted this last device as being, in its opinion, the most suitable for the problem in hand and on account of the minimum amount of machinery required and the minimum cost of masonry. The common ways of unwatering tunnels and shafts, where the work is done intermittently, is to use large centrifugal pumps, or, where conditions warrant it, to discharge the water by compressed air. The advantage of this system is that it will expel a large volume of water in proportion to the size of the plant required.

I see no reason why any of the systems could not be applied in this case. The compressed air lift plan could be used with advantage. The compressors need not be in the park, and, indeed, they might be at a considerable distance. It would be possible to put a sufficient plant in some cellar half a mile away and conduct the compressed air to the shaft by pipe. The air is forced down into the water through a tube, and starts the flow of water through another pipe which emerges at the top of the shaft.

By compressed air water can be lifted 2,000 feet by relays. Here the tunnel is less than 500 feet below the surface.

Louis Freidman, of Muncie, Ind., who recently purchased three discarded gas pumping stations near Fairmount, Ind., from the Indiana Natural Gas & Oil Co. estimates the iron and steel secured in the deal will aggregate about 480 car loads, and will require several months time to clean up and market. At the Fowlerton station there are 27 big gas compressors, each weighing about 35 tons.

It has been found in sounding the depths of the ocean that the temperature steadily decreases during the first 600 fathoms. When depths of 2 miles are reached the water approaches the freezing point. The depths of the ocean, even at the equator, register near 35 degrees. If some ingenious individual in the tropics will devise a method of sinking perishable foods into the depths of the ocean he will find a cold storage plant of unlimited capacity at his disposal.

Oxy-acetylene cutting played an important part in the dismantling and removal of fourteen large boilers at the plant of the Union Electric Light & Power Company, St. Louis, Mo. Each boiler was 11 feet in diameter by 21 feet long. The oxy-acetylene blowpipe permitted the cutting up of the boilers into small sections, such as could be easily removed without the necessity of tearing down a part of the building. The portable type of outfit was used, employing compressed oxygen and Prest-O-Lite gas. The cutting outfit was moved from boiler to boiler as the work progressed.

Continued from page 7928.

noticeable, but that in the last stages it is very good. The ultimate air temperature reached in the Allgemeine Elektricitäts Gesellschaft compressors under pressures from 85 to 115 lb. is about 167 deg. F. or less, depending on the temperature of the cooling water. The requirement of the latter with a 1000-hp. compressor at the foregoing pressures, for instance, amounts to about 1600 cu.ft. an hour, and increases approximately with the output.

As to the best speed, the rule is to give the smaller machines the highest possible, namely, 4000 to 5000 r.p.m., and the larger ones about 3000 to 3800.

As a minimum size the Allgemeine Elektricitäts Gesellschaft does not advise anything lower than 140,000 cu.ft. per hr. at from 70 to 85 lb. pressure for compressors and 35,000 ft. at about 20 lb. for blowers. These values might be taken as critical points, whereon the use of the reciprocating type in comparison with the turbine type would seem to be the more advantageous.

The wheels of the Allgemeine Elektricitäts Gesellschaft machines are made up of two nickel-steel disks between which the wrought-iron buckets are radially riveted. As to wheel diameters, in the case of the 3000-r.p.m. machine it is about 40 in., and decreases toward the pressure side, corresponding to the gradually smaller specific volume of the gas being compressed. For constructive reasons this decrease of diameter is not from wheel to wheel but from one group of wheels to another group, a number of similar wheels being assembled to form a group.

The Frankfurter Maschinenbau Allgemeine Gesellschaft builds steam-driven turbine compressors for outputs from 100,000 cu.ft. an hour up, and electrically driven at a minimum of 3,000 r.p.m. from about 200,000 ft. up, while for turbine blowers the output is from 70,000 ft. hourly for pressures up to 40 in. of water.

In line with the belief of this concern in the least number of wheels, it is today compressing to 7 atmospheres with 12 wheels. The buckets in these last are not radially disposed as in the Allgemeine Elektricitäts Gesellschaft machines, but suggest the spiral in their arrangement.

The Frankfurter Maschinenbau Allgemeine Gesellschaft has turned out a steam-turbine-driven turbo-compressor with a free-air capacity of over 350,000 cu.ft. per hr. to 7 atmospheres and with a horsepower requirement of 1150.

The Gutehoffnungshütte builds a turbo-compressor for from 425,000 to 635,000 cu.ft. of free air an hour compressed to 7 atmospheres. The average speed is about 3800 r.p.m. The same concern also makes a three-stage turbo-blower without water cooling. The capacity is from 600,000 to 700,000 cu.ft. of free air an hour compressed to between 7 and 8.5 lb.

THE STATUS OF NATURAL GAS COMPRESSORS

The art of natural-gas compressing is now over 25 years old, and has grown at practically the same rate as the increase in domestic natural-gas consumers. There are now over 200 natural-gas compressing stations in North America, aggregating more than 320,000 hp. of compressor capacity and representing a property value of more than $22,000,000, and compressing more than 85 per cent. of all the gas used. The age and magnitude of the art make it evident that the use of gas compressors is a recognized integral part and universal custom of the natural-gas business.

The public also is not without its rights and vital interests in this problem. Approximately 1,700,000 domestic natural-gas consumers in North America are dependent upon gas compressors for their natural-gas service. That is, if the use of compressors were to be prohibited, the majority of these consumers would be unable to secure adequate natural-gas service.

Each consumer represents between four and five persons, and it therefore follows that the comfort and well-being—as far as natural-gas service is concerned—of at least 8,000,000 persons would be affected if the use of natural-gas compressors should be prohibited. These 1,700,000 consumers have invested, in services, house piping, fixtures, and appliances, an average of about $90 each, or an aggregate of $153,000,000, which is much more than the companies' investment in gas compressors. Furthermore, in all cases where the rate paid by the consumers is fair to the gas company—considering the value of the service rendered by the gas company—the consumers are entitled to continued service and protection of the investment they have made on the faith that the gas service would be continued in the future.

Since "Customs adopted and acquiesced in, if not in conflict with federal or State legislation, have the force of positive law," and "Courts will take notice of whatever ought to be generally known within the limits of their jurisdiction," there ought to be no question as to the unqualified right to use gas compressors. However, many small gas-producers, not using gas compressors, have sought to secure permanent injunctions from courts to prevent other gas-producers from using such compressors. This has resulted in much expensive litigation.

The above is the introductory portion of a paper prepared by Samuel S. Myer, Columbus, Ohio, for presentation at the February meeting of the American Institute of Mining Engineers. The paper is a valuable chronological arrangement of all the court decisions relating to this important topic from 1885 to 1913.

AIR IN COMPRESSION AND EXPANSION

BY C. K. BENNETT.

In the compression of air all the work done is converted into heat and shows itself in the temperature of the compressed air. The accompanying chart* is based on air at atmospheric pressure and an initial temperature of 60 deg. The curves marked 1.41, 1.35 and 1.25 are plotted for the given exponents representing the ratio $Cp \div Cv = K$, and express the ratio of specific heat at constant pressure and constant volume.

When air is compressed adiabatically, all of the heat resulting from the compression is retained in it and the exponent of the curve is 1.41. For example: Adiabatic compression from 14.7 lb. absolute and 60 deg. F. to 200 lb. absolute. It will be seen by reading to the left from where the 200-lb. vertical line intersects the curve marked 1.41, that the temperature of the air after the compression is 651 deg., and by reading from the same point radially to the volume at the top, it will be found that one cu.ft. of free air when compressed under the conditions mentioned will equal 0.157 cu.ft. By reading again from the same point horizontally to the right (200 lb. on the 1.41 curve) it will be seen that there will be 64,200 B.t.u. given up to the air per hour, when compressing 100 cu.ft. of free air per minute.

Cooling the air during compression by the injection of water, radiation, etc., alters the value of the exponent curves *K* and therefore various curves of exponents are plotted, by means of which the temperatures, volumes and B.t.u. may be found for any condition.

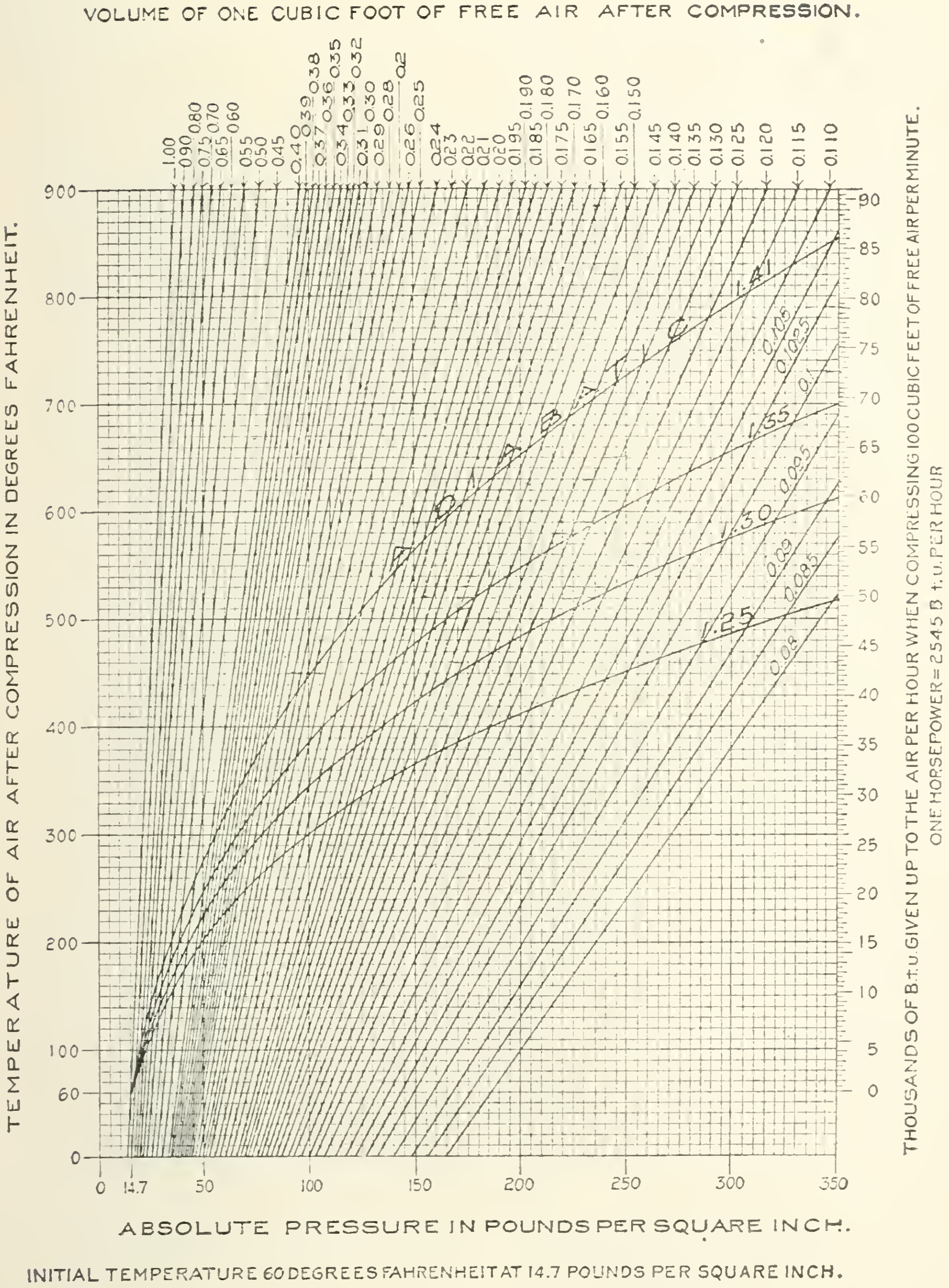
A compression curve with an exponent of 1.25 is the best result that was obtained at Quai De La Gare, Paris, in a single-cylinder compressor cooled with a very fine spray of water.

In addition to the volume and temperature, the theoretical horsepower required to compress the air may be found from the B.t.u. per hour for compressing 100 cu.ft. per min. to the desired pressure, and taking the same relative part of these B.t.u. as the number of cu.ft. that is desired to be compressed is of 100, thus getting the correct number of B.t.u. for the given amount of air at the given pressure. The B.t.u. found when divided by 2,545 will give the theoretical horsepower required; to which should be added the allowance for friction, clearance, etc., to correspond to the compressor under consideration. The final result will give the horsepower required to drive the compressor under the various conditions set forth.

The volume of 1 cu.ft. of free air after compression may be read directly, and by plotting all factors or values from the one curve, when the pressure line is followed up to the curve representing the exponent of compression and a pencil is held at that point, all factors can be read directly; that is, temperature, volume, B.t.u. (which by the way is a decided and valuable addition to the curve) and the horsepower required may be determined. The heat available for heating from the compressed-air transmission pipes can also be readily determined. *Power.*

---

*Copies of this chart, 17x20 in., may be secured from C. K. Bennett, 1949 East Monmouth St., Philadelphia, Penn., for $1 each.



AIR IN COMPRESSION AND EXPANSION.

TEMPERING MINE DRILLS

BY HUGH SPOTTISWOOD.*

I was born and brought up in Alston Moor, Cumberland, England, where lead mining was the principal industry. The majority of the mines were owned by the Government London Lead Company, and throughout all the company's mines they had a system of tempering drills that I have never seen anywhere outside of that company's works. The system I will explain later on.

I have had about fifty years' experience in mining. After leaving home, I worked in mines in Canada, in some of the largest iron ore and copper mines on Lake Superior, State of Michigan, U. S. A., in copper and silver mines in Montana, U. S. A., in lead mines in Wisconsin and in Ohio, U. S. A., at Gympie in Qeensland, and (where I am at present) Mount Morgan. I have worked with the drilling machine almost since the time it came into use. I have seen the advancement and improvements in the drilling machine, and in the different ways of sharpening drills, but I have never once seen any advancement from the old system of tempering drills. It is a system which has sometimes been the cause of men not being able to do fair amount of work on account of the drills not getting the proper temper. There were times in the Mount Morgan Mine when the machine men could not do any boring, because the drills were as soft as lead, especially the long drills.

I remember a time, about sixteen or seventeen years ago, when every drill that came into the mine was so soft we could do nothing with it. I was working in a hard drive at the time. When the mining manager came into the drive to make some inquiries about the drills, and I was going to tell that I knew of a system of tempering that would do away with all soft drills, he would not listen to me. Some years after that time a change took place; there was a new manager, and some time afterwards we were having another run of soft drills. Someone told the manager something; he came to me in the mine, began to make enquiries about the drills, and I told him all I knew about the matter. He looked at some of the drills that we had been trying to drill with, and the bits were as blunt as the head of a hand drill that had been beaten with a hammer. I explained my system of tempering and also what I thought was the cause of those drills being so soft. He at once saw the force of what I said, and stated that he would have the new system installed right away.

It so happened that at that very time they were putting into the blacksmith's shop drill sharpening machines, and the first drills to come from the drill-sharpening machines were the first drills to be tempered by the new system. Though, the machine being new to the men, I can tell you there were some comical-looking bits turned out for a little while, but the temper was all right. Nineteen men out of every twenty were under the impression that the new system of tempering came along with the drill-sharpening machine, as they were both installed at one time, and the same system is still in use. Now I will describe what I think was the cause for the soft drills.

THE CAUSE OF SOFT DRILLS.

In the centre of the blacksmith's shop stood a big iron trough full of water, and drills were being put into it from all sides to temper. Now, fine muck and black sediment soon began to accumulate in the bottom of the trough. A large quantity soon accumulates —probably 10 in. or 1 ft. of fine muck, which is all the time in the bottom and the water on top. The drills are all the time going into the muck and staying there for a while. The muck got the biggest part of the heat. When it gets the heat it keeps it, and becomes very hot, though the water may be changed two or three times a day. The changing of the water makes very little difference unless the outlet be right at the bottom, and this does not often happen, because we generally see these troughs sunk a foot or eighteen inches in the ground. I have watched the blacksmith sharpening drills many a time, and often see him, after having got the drill sharpened, put it into the edge of the trough, with the bit about 2 in. into the water, holding it there for a second or two, and then letting it go right to the bottom of the trough, when the bit becomes buried in the hot mud. There it will stay probably two or three hours. Now, I am of the opinion that whatever temper that drill had, it got while the blacksmith was holding it, and as soon as it went into the hot mud this hot mud took the temper out; and I think the reason why the longest drills were always the softest was because the longer the drill is the heavier it is, and it will sink the bit deeper in the mud.

---

*Queensland, Australia.

Now I will describe the other system of tempering. The system is to have the bit of the drill when in the water stand on a clean surface—machine drills in about 2½ in. or 3 in. of water, hand drills in about 1½ or 2 in. of water, the water to come in at one end of trough and run out at the other end. In my country we would use a stone flag, 3 ft. by 2½ ft., but as stone flags are not to be had in this country a flat sheet will answer the purpose just the same. Now, we want a trough 3 ft. by 3 ft., and about 1 ft. in depth, made to hold water, and sink it 6 in. into the ground to make it steady; it must be properly level, so that the water will be uniform on the flat sheet.

Then, there should be a flat sheet 3 ft. by 2½ ft., or small enough to go inside the trough, with 6 in. of space between the front of the trough and the flat sheet; also four pieces of 4 by 4 hardwood, 2 ft. 6 in. long, one piece to be laid at each end of the trough and the other two pieces between them, to be laid on the bottom of the trough and the flat sheet laid on top of the four pieces, with the 6 in. of space to the front of the trough, with a pipe to come through the trough at one end about 5 or 6 in. above the flat sheet, and with a tap on it, so that the blacksmith can cut the water off when not in use. A hole should be cut through the trough, if for machine drills, about 2½ or 3 in. above the flat sheet. The outlet can be easily altered if found to be not right. The less water the harder will be the temper; the more water the softer the temper. Now, the drills have to stand upright with their bits in the water on the flat-sheet. It is necessary to have a sort of fence at the back and the two sides for the long drills to rest against. The 6 in. of space which is at the front of the trough, which is about 5 in. in depth, is to hold the muck which will accumulate on the flat, which should be swept with a broom every time it is clear of drills. The front part of the trough is also used for tempering picks and hammers.

Now that I have described the system as well as I can, it will be seen that it is easier for the blacksmith. All he has to do is to stand his drills on the flat sheet, one up against another, and leave them there and they will temper themselves. If a drill is set into the water with a white heat on it, it will be too hard and brittle, but that does not often happen. It is not only here that I have had trouble with drills tempered by the old system, but in a good many places where I have been, especially with machine drills. I think any big mining company that has large quantities of drills to handle, if they adopt the system which I have described, will have no cause to regret doing so. There is not much expense about it; the only drawback it has is that it takes a little more water than the other system.

NOTES

Experts agree that the gas well brought in recently by the Guffey Petroleum Co. on its White Point lease, seven miles from Corpus Christi, Texas, is the greatest producer in the world, the flow being estimated at 30,000,000 cubic feet daily. It is the third big gasser that has been brought in on the White Point tract within the past 15 months, two being brought in by the Guffey company.

Brazil has an area of 3,292,000 square miles, which is greater than the United States exclusive of Alaska, and a population of 24,000,000, which is one-quarter of that of the United States; Rio de Janeiro, the capital, has 1,500,000. Ocean-going steamers can ascend the Amazon to Manaos, which is farther inland than Chicago or St. Louis. Shipments of iron and steel, machinery and oils from the United States to Brazil are increasing rapidly.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 4.

1,166,430. PNEUMATIC SHIFTING DEVICE FOR MOVABLE MEMBERS OF AN AUTOMATIC MUSICAL INSTRUMENT. Charles S. Burton, Oak Park, Ill.

1,166,439. AIR-RELIEF VALVE FOR WATER-MAINS AND THE LIKE. Justus N. Corbin, Fruita, Colo.

1,166,455. PNEUMATIC ACTION FOR PIANO-PLAYERS. Archie N. Grimes, Chicago, Ill.

1,166,503. AIR-VALVE. Clayton Weaver, Phalanx, Ohio.

1. In a motor vehicle the combination of a brake mechanism; a clutch mechanism; a rod for operating each of said mechanisms; manually controlled means for operating each of said rods; an air cylinder for said brake mechanism; an air cylinder for said clutch mechanism; a piston in each of said cylinders; means for admitting compressed air behind each of said pistons; and a sliding connection between each of said rods and said pistons adapted to permit the manual operation of said brake and clutch mechanisms without affecting said pistons and to also permit the operation of said brake and clutch mechanisms by admitting compressed air behind said pistons, substantially as described.

1,166,522. AIR-BRUSH. **Birchard E. Holton**, Los Angeles, Cal.

1,166,659. CENTRIFUGAL FAN. **Willis H. Carrier**, Buffalo, N. Y.

1,166,855. SAFETY DEVICE AGAINST EXPLOSIONS IN THE AIR-PIPES OF INTERNAL-COMBUSTION ENGINES. **Conrad C. Regenbogen**, Kiel-Gaarden, and **Paul R. Ritter**, Kield, Germany.

1,166,945. PNEUMATIC PRINTING FRAME. **Emanuel W. Sweigard**, Chicago, Ill.

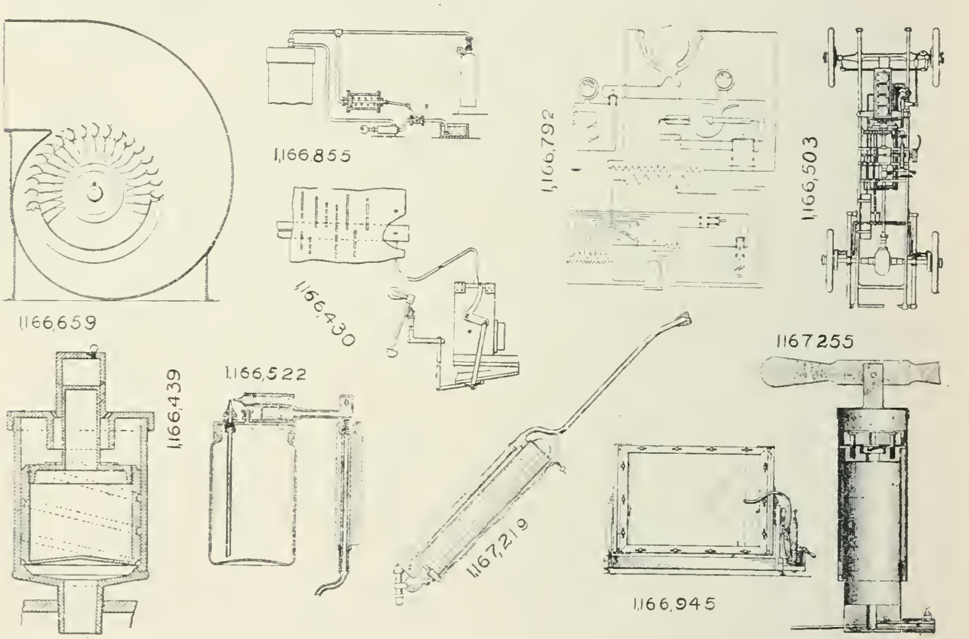
1,167,219. PORTABLE VACUUM-CLEANER. **Daniel Benson Replogle**, Berkeley, Cal.

1,167,255. AIR-PUMP. **Alvin R. Berck** and **Fred Tjaden**, Hastings, Nebr.

JANUARY 11.

1,167,421. PRESSURE INDICATING AND REGULATING DEVICE. **Henry W. Maurer** and **Fred K. Taylor**, Rochester, N. Y.

1,167,492. ART OF IMPREGNATING TIMBER AND OTHER POROUS MATERIAL WITH A PRESERVATIVE. **Oliver P. M. Goss**, Seattle, Wash.



Pneumatic Patents January 4.

1,166,719. FLUID-PRESSURE GAGE. **Joseph Shebol** and **William F. Albrecht**, Syracuse, N. Y.

1,166,723. ATTACHMENT FOR PNEUMATIC MACHINE RIVETERS. **Wiley Stark**, Devils Slide, Utah.

1. As an article of manufacture, a tool for use on machine riveters, the tool presenting a head to be introduced between the riveter set and the work, and means independent of the said riveter set whereby said head may be held in position on the riveter in position for use.

1,166,792. EVACUATION PROCESS. **Homer Clyde Snook**, Cynwyd, Pa.

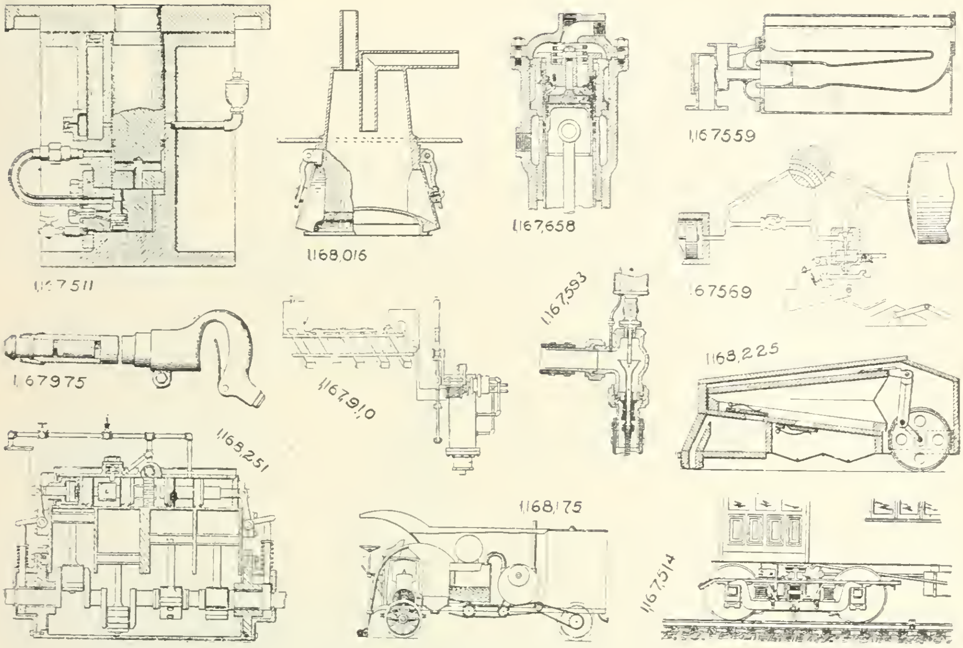
1. As an improvement in the art of exhausting bulbs, the method which consists in partially exhausting a bulb, passing energy through the remanent atmosphere between an anode and cathode, heating said cathode by said energy, and further exhausting said bulb during passage of energy until the cathode glow fills said bulb and acts upon the inner walls thereof.

1,166,854. PNEUMATIC WHEEL. **Joseph O. Raymond**, Concord, N. H.

1. In the preserving treatment of porous material, the method which consists in immersing the material in the preservative fluid contained in a closed container and then heating the fluid to approximately 230 degrees Fahrenheit, then emptying the container of the preserving fluid and drawing a vacuum therein of from 23 to 28 inches approximately and simultaneously heating the interior of the container to a temperature of from 150 to 230 degrees Fahrenheit, and continuing such treatment for upward of half an hour, then breaking the vacuum in the container by the re-introduction therein of the preserving fluid, then applying pressure to the fluid sufficient to force into the pores of each cubic foot of the material approximately five to twenty pounds of the fluid.

1,167,514. PNEUMATIC FLANGE-OILER FOR CAR-WHEELS. **August W. Olsen**, Portland, Oreg.

1,167,511. JOLT RAMMING-MACHINE. **Edgar H. Mumford** and **Edward Melville Huggins**, Plainfield, N. J.



Pneumatic Patents January 11.

1,167,518. MANUFACTURING FROTH FILLINGS. Fritz Pfleumer, Dresden, Germany.

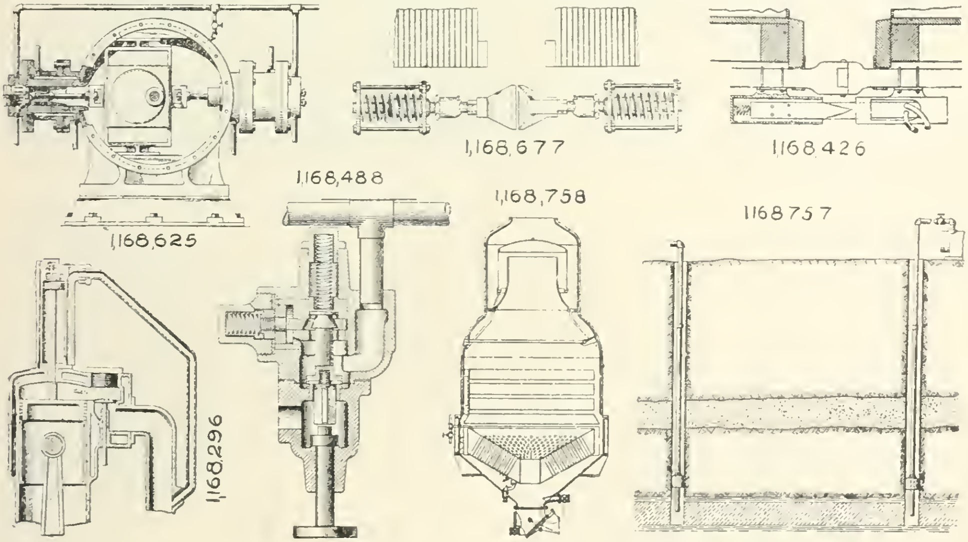
1. The process of manufacturing froth fillings which comprises the steps of vulcanizing vulcanizable material under a hot high gas pressure, then cooling the same under a cool gas pressure at least equal to the gas pressure applied during vulcanization, inserting the cooled filling into a casing, and then heating the filled casing to expand the filling until it occupies the interior of the casing.

1,167,559. HYDRAULIC DEVICE FOR COMPRESSING GASES. Kenneth Gauldie, Glasgow, Scotland.

1,167,569. AUTOMATIC AIR-CONTROLLING DEVICE FOR VEHICLE-BRAKES. Elmer M. Jones, Atlanta, Ga.

1,167,593. AIR-PRESSURE LUBRICATOR. Lewis G. O'Donnell, Coscob, Conn.

1,167,658. HIGH-PRESSURE GAS-COMPRESSOR. Edwin Prestage, Stoke Newington, London, England.



Pneumatic Patents January 18.

1,167,740. METHOD OF CONTROLLING THE HUMIDITY OF AIR UNDER PRESSURE. Willis H. Carrier, Buffalo, N. Y.

1,167,910. AUTOMATIC TRAIN-STOPPING DEVICE. Harry W. Marston, Everett, Mass.

1,167,975. PNEUMATIC-TOOL PISTON. William Burlingham, Newport News, Va.

1,167,980. INDICATOR FOR PNEUMATIC TIRES. Samuel F. Cole, Purcellville, Va.

1,168,001. PNEUMATIC ACTION FOR PIANO-PLAYERS. John Hillstrom and Amil Hawkinson, Chicago, Ill.

1,168,016. MILKING-MACHINE. James F. Lemon and Samuel A. MacDonald, Syracuse, N. Y.

1,168,040. APPARATUS FOR RAISING SUNKEN VESSELS. Olaf M. Wick, Jamestown, N. D.

1,168,105. BLOWER FOR SIGNALING DEVICES. Nelson Nyberg, Miami, Ariz.

1,168,175. VACUUM STREET - CLEANER James E. Deardorff, Wichita, Kans.

1,168,225. CARPET-CLEANER. Frank J. Quist, Worcester, Mass.

1,168,251. AIR-COMPRESSOR MOTOR. David E. Crouse and Charles G. Eidson, Annapolis, and Thomas Davis, Baltimore, Md.

JANUARY 18.

1,168,296. POWER TIRE-PUMP. Frederick G. Folberth, Cleveland, Ohio.

1,168,426. AUTOMATIC AIR-HOSE COUPLING. John Roy, Los Angeles, Cal.

1,168,456. COUPLING FOR AIR CONDUITS. Melville Arnold, Lima, Ohio.

1,168,488. TRIP-VALVE FOR AIR-BRAKES. Edward H. Dewson, New York, N. Y.

1,168,493. AIR-BLAST COTTON-GIN. Carrollvernon B. Ginn, Brenham, Tex.

1,168,506. PNEUMATIC ELECTRIC FIRE-ALARM. Christian John Jenne, San Francisco, Cal.

1,168,625. COMPRESSOR. Lee H. Geisendorff, Indianapolis, Ind.

1,168,677. AUTOMATIC TRAIN-PIPE COUPLING. George G. Ross, Harry E. Ross, and Leo D. Ross, Greensburg, Pa.

1,168,691. PNEUMATIC PLAYER MECHANISM. Frank C. White, Meriden, Conn.

1,168,757. METHOD OF LOCATING NATURAL GAS. Frederick Squires, McConnelsville, Ohio.

1. The method of determining the location and probable direction of extent of gas or oil bearing strata which consists in sinking three or more wells to such strata at relatively remote points, creating an artificial pressure at one well which shall be observable at the other wells when the wells communicate with a common stratum, and recording the pressures at all of the wells, whereby the general direction of flow of the fluid in the stratum is indicated.

1,168,758. VACUUM EVAPORATING APPARATUS. George Stade, Schloss Hubertusberg, Germany.

1,168,924. PNEUMATIC PLAYER MECHANISM. Frank C. White, Meriden, Conn.

1,169,050. AUTOMATIC AIR - CUSHION. George W. MacKinnon, Boston, Mass.

JANUARY 25.

1,169,126. PNEUMATIC ACTION FOR INTERIOR PIANO-PLAYERS. Melville Clark, Chicago, Ill.

1,169,131-2. ACTION FOR PIANO-PLAYERS. Charles L. Davis, Detriot, Mich.

1,169,177. CONFINED - COMBUSTION GAS-BURNING APPARATUS. Lee B. Mettler, Kansas City, Mo.

1,169,277. VALVE FOR PNEUMATIC TIRES. Joseph N. Newsom, St. Louis, Mo.

1,169,308. HOT-AIR ENGINE WITH CLOSED CIRCUIT. Trajan Vuia, Neuilly-on-Seine, France.

1,169,371. METHOD OF DRYING AIR FOR METALLURGICAL USES. Wilhelm Wense, Griesheim-on-the-Main, Germany.

1,169,373. TRAIN-PIPE COUPLING. Walter C. White, Los Angeles, Cal.

1,169,438. AIR-PUMP. Clayton S. Stevens, New Britain, Conn.

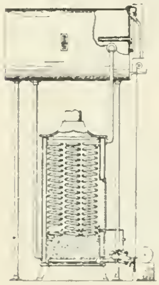
1,169,527. VACUUM-CLEANER. Charles A. Boyer, Warsaw, Ind.

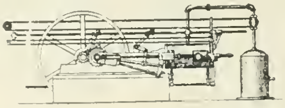
1,169,558. SPRAYING DEVICE FOR LIQUID PAINT AND THE LIKE. George More, Richmond Hill, and Edward W. Spies, New York, N. Y.

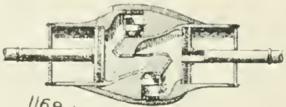
1,169,582. DRILLING OR BORING TOOL. William Maine Treglown and William Noble, London, England.

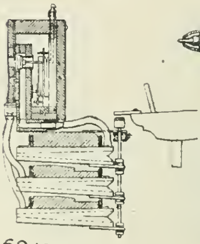
1,169,587. AIR - BRUSH. Olaus C. Wold, Chicago, Ill.

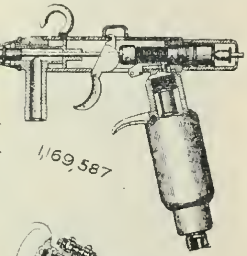
1,169,672. COMBINED GAS AND AIR ENGINE. Victor H. Palm, Butler, Pa.

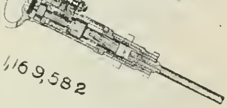

1,169,177

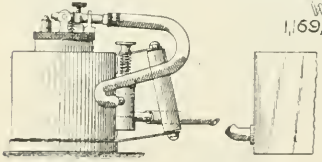

1,169,672

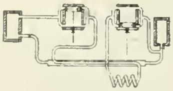

1,169,373

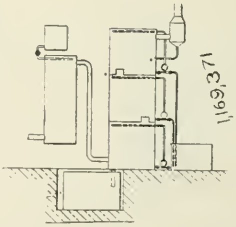

1,169,126

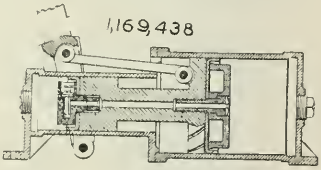

1,169,587


1,169,582


1,169,558


1,169,308


1,169,371

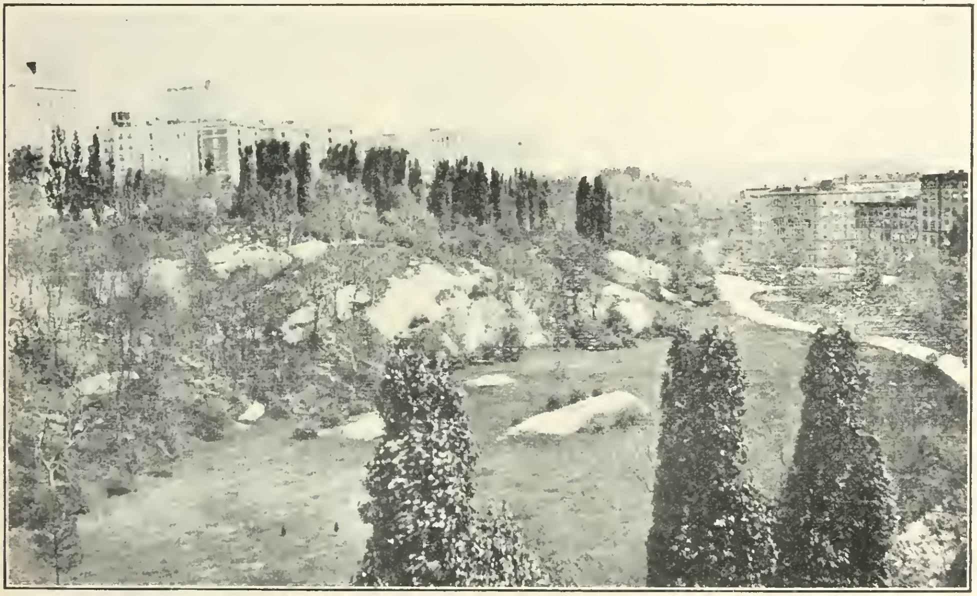

1,169,438

Pneumatic Patents January 25.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

1134

Vol. XXI APRIL, 1916 No. 4



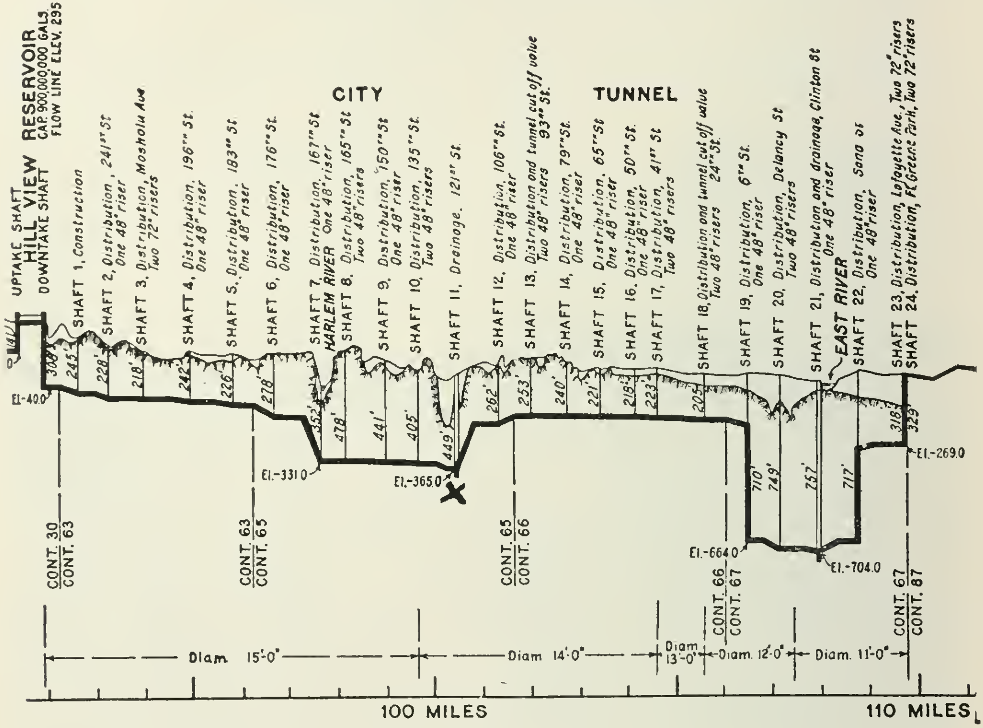
MORNINGSIDE PARK FROM 110TH STREET.

THE PUMPING PROBLEM IN MORNINGSIDE PARK

BY FRANK RICHARDS.

An interesting discussion is in progress in connection with the unwatering equipment now being installed in Morningside Park, New York City, by the engineers of the Catskill aqueduct. It is imperative that when the aqueduct has been filled with water and submitted to full service pressure there shall be ready means for rapidly unwatering it, at least for inspection, and also to provide an opportunity for making such repairs as may appear to be necessary. The plant must also be a permanent one to be ready for any emergencies later.

It is also practically imperative that the unwatering plant shall be located at the precise point selected, because here is located the shaft (No. 11) which connects with the lowest point of the city aqueduct in the 14 miles from Hill View Reservoir to the much deeper siphon by which the aqueduct passes under the East River, which will be unwatered by another installation at Clinton Street. To be quite correct, the portion to be unwatered by the plant here spoken of extends only down to 93rd Street a distance of about 10 miles, and the total volume of water to be lifted at each unwatering, will be a little over 70,000,000 gallons.


UPTAKE SHAFT
HILL VIEW
DOWNTAKE SHAFT
RESERVOIR
CAP. 900,000,000 GALS.
FLOW LINE ELEV. 295'
CITY
TUNNEL
SHAFT 1, Construction
SHAFT 2, Distribution, 241st St One 48" riser
SHAFT 3, Distribution, Mosholu Ave Two 72" risers
SHAFT 4, Distribution, 196th St. One 48" riser
SHAFT 5, Distribution, 183rd St One 48" riser
SHAFT 6, Distribution, 176th St. One 48" riser
SHAFT 7, Distribution, 167th St One 48" riser
HARLEM RIVER
SHAFT 8, Distribution, 165th St Two 48" risers
SHAFT 9, Distribution, 150th St One 48" riser
SHAFT 10, Distribution, 135th St. Two 48" risers
SHAFT 11, Drainage, 121st St.
SHAFT 12, Distribution, 106th St. One 48" riser
SHAFT 13, Distribution and tunnel cut off valve 93rd St. Two 48" risers
SHAFT 14, Distribution, 79th St. One 48" riser
SHAFT 15, Distribution, 65th St One 48" riser
SHAFT 16, Distribution, 50th St. One 48" riser
SHAFT 17, Distribution, 41st St Two 48" risers
SHAFT 18, Distribution and tunnel cut off valve 24th St. Two 48" risers
SHAFT 19, Distribution, 6th St. One 48" riser
SHAFT 20, Distribution, Delancy St Two 48" risers
SHAFT 21, Distribution and drainage, Clinton St One 48" riser
EAST RIVER
SHAFT 22, Distribution, Sand St One 48" riser
SHAFT 23, Distribution, Lafayette Ave., Two 72" risers
SHAFT 24, Distribution, Ft Greene Park, Two 72" risers
308'
245'
228'
218'
242'
226'
278'
352'
478'
441'
405'
449'
262'
253'
240'
221'
218'
223'
205'
710'
749'
757'
717'
318'
329'
El-40.0
El.-331.0
El.-365.0
X
El.-664.0
El.-704.0
El.-269.0
CONT. 30 / CONT. 63
CONT. 63 / CONT. 65
CONT. 65 / CONT. 66
CONT. 66 / CONT. 67
CONT. 67 / CONT. 87
Diam 15'-0"
Diam 14'-0"
Diam 13'-0"
Diam. 12'-0"
Diam. 11'-0"
100 MILES
110 MILES

PROFILE OF N. Y. CITY TUNNEL, PUMP IN PARK AT X.

The excellent plan adopted by the engineers of the aqueduct of locating the construction shafts, wherever possible, in the parks of the city, or in such locations as to least interfere with the traffic and life of the city, has been universally commended, and the commendation applies to the location of shaft No. 11 in Morningside Park as well as to the others. When, however, this shaft is to be used also for unwatering the aqueduct whenever necessary, this necessitating the erection of a large, unsightly and incongruous structure in an attractive and .frequented portion of the park, we must concede that there has been a deplorable error of judgment. As this shaft is not immediately over the line of the aqueduct, but is connected with it by a lateral tunnel, it is evident that it might have been located outside of the park anywhere in the vicinity, and where a suitable building might have been entirely admirable and appropriate.

However, the conditions being as they are, it is necessary to make the best of them, which leads to the considering of the essential mechanical features of the plant which is being installed. The principle adopted is admirable for its simplicity, and it is no wonder that engineers express their approval of it. The unwatering operation may be briefly described as follows:

At the beginning of the unwatering, the shaft being full, or nearly full of water, there is floating upon the surface of the water,. of course partially submerged, a hollow steel cylinder closed at the bottom, nearly 13 feet in diameter and more than 20 feet high. Within this floating cylinder there are powerful four stage centrifugal pumps and electric motors for driving them. The water enters the pumps by passages in the bottom or side of the float, and, as the submergence of the float is practically constant, no matter how much the water in the shaft may be lowered, there is no change in the pump intake or suction conditions until the unwatering is completed. The water delivered by the pumps is carried up a vertical pipe and discharged into a sewer. That is all; and how could anything be simpler, or why should not engineers admire and endorse it?

It may be added that this device is not new, and is not in any way experimental. It has been used for unwatering mines and is also satisfactorily employed at other points on the Catskill aqueduct system. It is scarcely justifiable, however, to assert that this is the only device that could be used at shaft No. 11, and it is even a debatable question whether it is in fact the best device that could be selected.

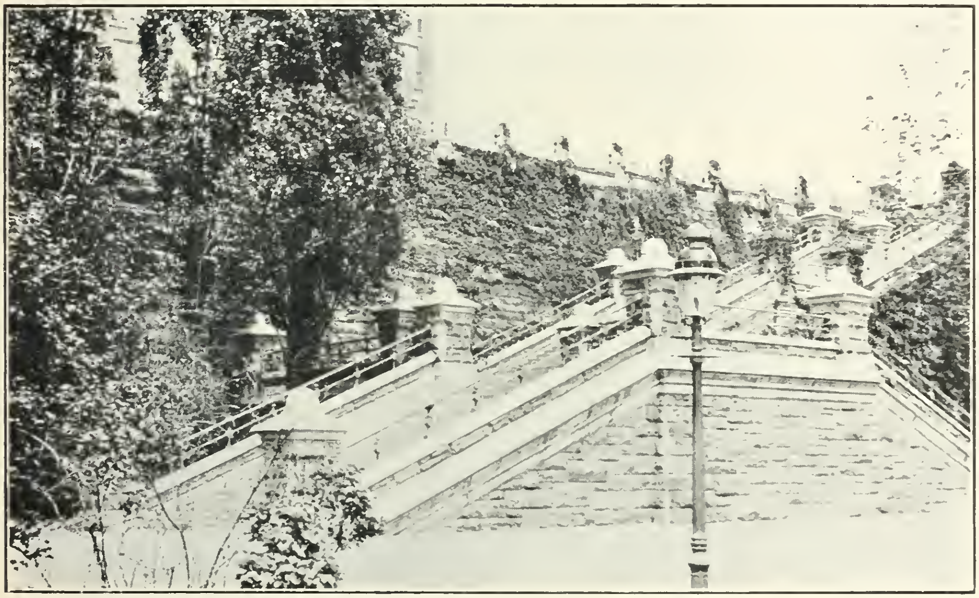
Looking now a little at the details of the unwatering operation as sketched above, it is to be remembered that when the unwatering is ordered the first thing to be done is to lift the float, to move it laterally until it is directly over the shaft, and then to lower it down into the shaft until it floats upon the water—and it weighs 40 tons.

This partially accounts for the height of the house, for the heavy steel framing of the building, and for the powerful hoisting apparatus required to be installed. The vertical water discharge pipe will then have to be hoisted and secured in place, length by length as the pumping proceeds, until at last there will be nearly 500 feet of it. Any one can easily imagine what will be the weight of a single length of this pipe 20 feet long, 10 inches in diameter and strong enough to safely stand a head of 450 feet of water, and also what will be the aggregate weight of the entire discharge pipe.

The pipe, by the way, must be carried to a height 30 or 40 feet above the required delivery level, and all the water must be pumped that additional and otherwise unnecessary height on account of the telescoping arrangement for the continuity of the discharge pipe as the float descends through the intervals between the successive additions of the 20 ft. lengths. When each additional length of pipe is to be inserted the pump must be stopped for a time sufficient to make the connection.

After the unwatering is completed the discharge pipe must be disconnected and hoisted piece by piece and laid away until the next unwatering, and the cumbrous float also must be hoisted and moved to the side, all of which work is chargeable to each single unwatering.

For the completion of the comparison purposed to be made it is proper to insert here



MORNINGSIDE PARK—STAIRWAY AT 116TH STREET.

the enumeration of the supplementary apparatus contained in the pump house as furnished by the engineers of the aqueduct.

"In the chamber at the top of the shaft is a large reel for the electric cables conveying the power and light current to the float, electric transformers, switchboard, and other electric apparatus for hoisting the discharge pipe sections, a hoist for operating the elevator which carries the operatives and supplies from the chamber to the float, duplicates for certain parts of the equipment and miscellaneous appurtenances."

The imperative necessity for the building in Morningside Park, for the area and the height of it, and also for its location in the precise spot selected, is sufficiently evident if the float pumping system is employed. It is under the circumstances certainly proper to consider the claims of other devices which are without the one, in this case, highly objectionable feature. Only the claims of the Air Lift will here be presented, and they would be deserving of consideration in any case, since the air lift is now frequently selected in open competition with all the known devices for pumping water all over the country and to suit a great range and variety of conditions.

A simple air lift consists of a vertical water discharge pipe extending down into the water a considerable distance below the lowest level to which the water is to be pumped, and a parallel pipe of much smaller diameter for conveying the compressed air to the lower open end of the water pipe. This air pipe may be within the water pipe or at the side of it. The water pipe is without valves or operating parts, or anything requiring manipulation of any kind, and for the air pipe there is only a valve for turning on the compressed air or shutting it off, or in some cases for partially closing the pipe to control the actual quantity of air used, as it may be required. The valve on the air pipe may be located anywhere along the line of it, so that there is no possible excuse for anything pertaining to an air lift above the level of the point of discharge.

The compressors for supplying the air for the lift may of course be located within any reasonable distance, say a mile in this case, and they require no comment here. They would presumably be two-stage machines with electric motors.

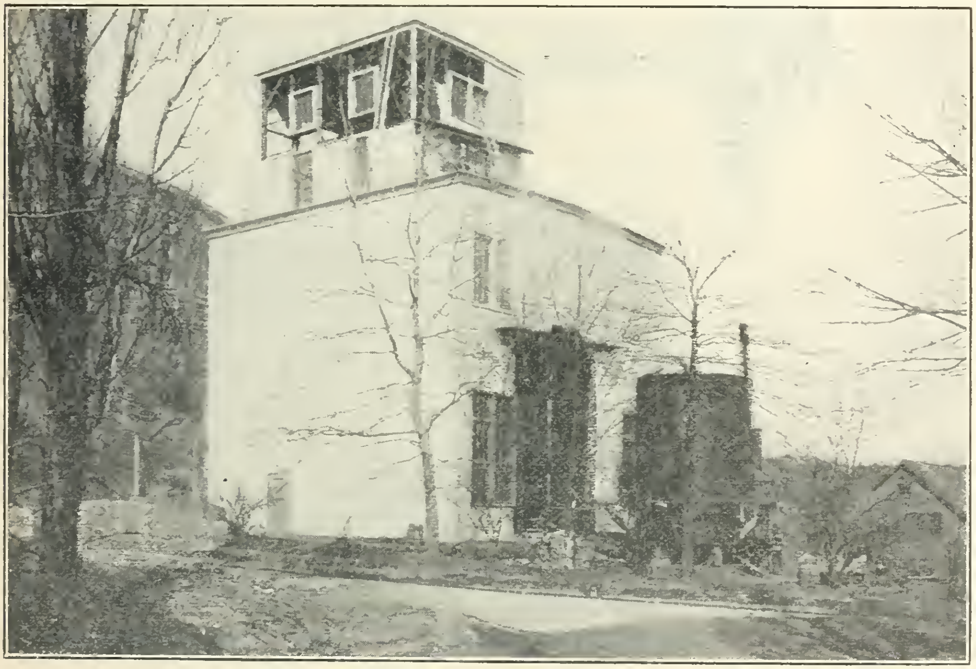
To speak more specifically: for the unwatering of the aqueduct at shaft No. 11, it would be advisable to install in the shaft two or possibly three air lifts which would be duplicates of each other, so that we here need consider only one of them.

To provide the necessary submergence for the discharge pipe, which would be say 12 in. in diameter, it would be necessary to bore a hole or supplementary shaft not over 18 in. in diameter down into the solid rock to a depth of say 200 ft. below the present bottom of the shaft. In the present state of the art, and with the special drills now provided for this purpose, this would be a simple matter, and this would be the only requirement in preparation for the air lift installation.

It is assumed that the water in the shaft, and all the water in this section of the aqueduct which is above the sewer level has been allowed to flow off by gravity, and the air lift operation now commences. The water level may be 20 ft. below the surface of the park and the floor of the building which has been erected here. We have now a 12 in. water discharge pipe in the shaft, supported and held in position by any suitable means, the upper end a little above the sewer level, so that the water as delivered will flow off freely, and the lower end a sufficient distance from the bottom of the submergence hole to permit the aqueduct water at all times to flow in freely to the full capacity of the pipe.

About 250 ft. below the top of the discharge pipe a side opening, as for instance a tee, will be provided to which will be attached a compressed air pipe delivering air at a pressure something less than 125 lbs. per sq. in. or sufficient to overcome the pressure of the 250 ft. of water above it. Means should be provided in the discharge pipe for distributing the air all through the water in bubbles as small as possible instead of in unbroken masses. These bubbles rise and spread up through the water, with the inevitable result that the column of mixed air and water in the discharge pipe will be specifically lighter than the solid water outside the pipe, and the latter therefore will tend to drive the former up the pipe to preserve the balance. As the mixture of air and water thus rises and overflows the top of the pipe it will be successively replaced by solid water flowing in from below to be in its turn aerated and driven upward, and that is the air lift in full operation. After the air is discharged into the water it has no more effect as to lifting the water by pressure and the subsequent movement of the column is due entirely to gravity. The operation of aeration, levitation and forced ascent of the column will continue uninterruptedly as long as the supply of air at sufficient pressure is maintained and the water supply is not exhausted.

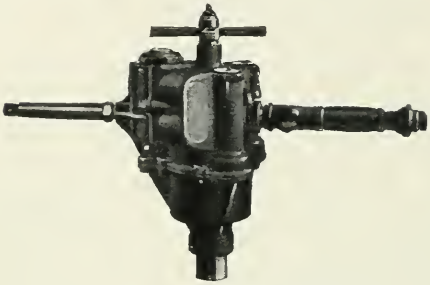
The pressure required for the air will always be automatically determined by the height of the solid water above the point at which the air enters the discharge pipe, this height being called the air lift submergence. As the air lifting is continued, and the surface of the body of unaerated water is lowered, the pressure required to force the air down into the water will be reduced correspondingly. When the water level outside the discharge pipe is lowered to a point say about 50 ft. above the air connection the air pressure will be about 25 lbs., and it will be proper to shut off the air at this point and to open the valve in another compressed air pipe similarly connected to the water discharge pipe, but say 200 ft. lower, at the bottom of the main shaft or near the top of the supplementary submergence shaft. The air pressure required here will be again more than 100 lb., on account of the relatively greater height of the surrounding solid water. As this air is turned on the air lifting is resumed again and may be continued as before until the water level is brought down again to say 50 ft. above the air connection. If now the air is shut off from the discharge pipe at this point, and the valve is opened in a third air pipe which will deliver the air into the water pipe at the lower end of it, down at the bottom of the submergence shaft, this will lift the remaining body of water in the system and bring the water level down to the bottom of the shaft, thus completing the job of unwatering.



PUMP HOUSE IN MORNINGSIDE PARK. PUMP FLOAT AT THE RIGHT.

The above is a brief sketch of the essential features of operation of the relay system of air lifting. It will be seen that it completely solves the problem before the engineers. The dimensions and details can be determined by those of practical experience in this special line, and the capacity of the installation to be provided will be determined by the time allowed for the unwatering.

The centrifugal pump system is not of high efficiency, and that of the air lift is still lower, but the difference in operating cost so far as the power is concerned will be offset by the additional labor cost in the case of the floating pump scheme.



A BIG LITTLE DAVID

The "Little David" line of pneumatic drills, manufactured by the Ingersoll-Rand Company 11 Broadway, New York, has now an additional number, exceptionally powerful, compound geared, designated model No. 11, SE. This drill is reversible and is adapted to the heaviest flue rolling, drilling, reaming and tapping. It is particularly recommended by the manufacturer for tapping on flexible stay bolt work, running-in stay bolt sleeves, for locomotive valve setting, and kindred heavy duty operations. It is so constructed that it develops full power on the reverse as well as the forward motion. This is pointed out to be of particular advantage, in that, after running a flexible stay bolt sleeve up tight, the No. 11 SE, due to its unusual power on the reverse motion, will also unscrew the sleeve cap. This obviates the necessity for the usual cumbersome wrench. In setting locomotive valves this new "Little David" tool has the same advantage, in that it will rotate the drivers in either direction facilitating the valve setting operation

This drill has the one piece, gear timed valves and ball and roller bearing crank shaft and connecting rods, and general simplicity of construction which have been features of the pneumatic drills of this manufacturer. The drill is ordinarily furnished with a No. 5 Morse taper socket. It operates at a normal spindle speed of 100 r.p.m.

WAR DESTROYS QUARRIES

One feature of the great European war in its relation to the stone trade we have not seen touched upon. Much of the severe fighting in Belgium and France has been in the quarrying districts. It was reported early in the contest that some of the great quarries had been utilized as cannon pits and as shelters for the soldiers. During the recent terrible struggle in the Verdun sector the French took refuge in a deep cave at the rear of a quarry at Louvemont, and the Germans made repeated efforts to dislodge them. During all of this fighting there has been a continual rain of shells loaded with the most powerful explosives known. During the first week of the fighting at Verdun it is stated that the Germans fired no less than 3,000,000 shells. Eye-witnesses tell of the terrible havoc wrought by these shells, as well as by the mines that are continually exploded. Vast craters are blown out of the rock and soil, and fortresses of steel and concrete are crumbled into fragments. Every stone man is aware of the fact that a single careless explosion of dynamite may ruin an entire deposit of valuable stone. It would seem, therefore, that this ceaseless hail of shells must have shattered all the ledges of stone within their radius so that there can be no possible utilization of the material in the future for building or decorative purposes. Of course, all of this is of small consequence in comparison with the terrible loss of life, and yet it serves to illustrate the awful waste of war.—*Stone.*

DRYING FILMS FOR THE MOVIES

The drying of photographic films by the ordinary method is a slow process and is the cause of much delay in the manufacture of the long strips required for moving pictures. To reduce the time of production one of the big film companies has introduced a special apparatus that greatly facilitates the process. The wet films are wound spirally on large drums 27 feet in diameter, which are introduced into a casing that has a 3,000-watt air heater set in the back. The current is turned on, and the drum is steadily revolved by a small electric motor, with the result that the film is now thoroughly dried in about one-fourth the time previously required, which varied from 4 to 10 hours according to the humidity of the atmosphere.

CO-OPERATION OF AMERICAN ENGINEERS WITH THE UNITED STATES GOVERNMENT

The following is from the address of President W. L. Saunders of the American Institute of Mining Engineers at the annual meeting, New York, Feb. 15, 1916.

During recent months there has been a marked change in the relations of the Institute to its fellow societies and to the Government of the United States. That change is in the direction of co-operation. The Secretary of the Navy has appointed two of your members to the Naval Consulting Board to co-operate with members of ten other scientific organizations. This board is now organized, and through its work your Institute is brought into close touch with the activities of the other societies and with the United States Navy.

The President of the United States has requested us to recommend to the Government one of our representatives in each State in the Union to act in collaboration with a member in each State from the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Chemical Society, thus organizing a directorate of engineers for each State, which will conduct, through the members of each of the five societies referred to, living in each State, a campaign of industrial preparedness.

No more important step than this, it seems to me, has been made in the history of your Institute. The work which these forty-eight boards are expected to do will be directed by a committee of the Naval Consulting Board, and the far-reaching effect and usefulness of this work can hardly be over-estimated. We hear a great deal about preparedness. Many plans have been suggested for increases in the army and navy of the United States and much difference of opinion exists on the subject. As far as I have observed, there is no difference of opinion on the question of industrial preparedness, which means a co-ordination and co-operation with the Government of our mines, mills, works, and factories, so that in the event of trouble they may be in a position to respond promptly, energetically, and with full force, to the needs of the nation.

Even as a peace measure such an organization is desirable. This country is the largest nation in the world industrially, yet our industries are working more or less at cross purposes, are not in touch with each other or with the Government. Such contact as has existed in the past between business and Government is a special, not a general, contact. Certain industries have had the ear of the Government, while others have not. Nor is the Government at present in a position to feel the pulse of the great industrial strength of the United States in peace or war. In this and in many other ways a general contact will not only be beneficial to the Government but should prove of wholesome advantage to our American industries.

The engineer has been called upon to take this important step. Who is better fitted to do it and do it well? Mind you, it is not the mining engineer alone, but the civil, the mechanical, the electrical and the chemical engineers, co-operating as a unit. We have heard a great deal about the desirability of co-operation among engineers, but so far it has been mainly academic. Here we have a practical fulfillment of our desires and an opportunity the importance of which can scarcely be measured. It is no less important to the engineer and to the whole profession he represents than it is to the industrial strength and prosperity of the nation.

The engineer is essentially a man of action, an executive, an administrator, not a mere scientific worker, operating behind closed doors in a dusty laboratory or over a drawing board. His place is out in the middle of the road, with his coat off, leading men, and initiating and directing measures of usefulness to the whole people. We have heard our profession defined as one which uncovers the hidden forces of Nature and puts them at the service of mankind. We have done a good deal in the line of uncovering these hidden forces, but have been very slow in our activities in placing the things revealed in useful operation. Modesty is not only a characteristic but a fault among engineers.

Some consider it undignified to get what they call notoriety, but it seems to me that there is a difference between notoriety and reputation; the way to get reputation is to do things, not under a bushel, but in the light so that the world may know and the full measure of benefit may be derived by inspiring public confidence not alone in what has been achieved, but in the personality of the individual who is responsible for the achievement.

Your Institute, like other long established scientific bodies, has an integrity beyond reproach. It does not work for money but for scientific advancement. Let its usefulness be extended to broader fields and let us resolve to make this organization, which has now been called for by the President of the United States, a useful and permanent force in our whole national life.

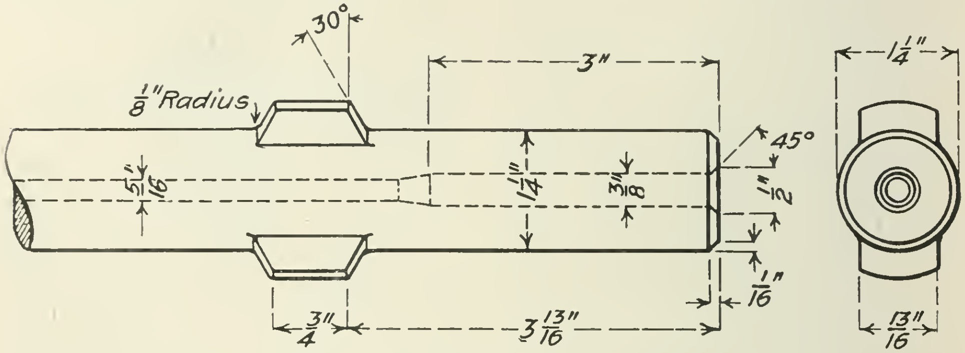


FIG. I. DRILL SHANK ON ROUND STEEL.

DRILL SHANKS AND BITS

By P. B. McDonald

The matter of drill-steel shanks is not clearly understood by many mine-superintendents, particularly as applying to steel for the increasingly popular mounted hammer-drill type of drills. Obviously it is not possible to use the same sort of chuck with a hammer-drill as is employed in a piston-drill, because the pounding by the hammer on a steel that is rigidly held would only waste the effort. The so-called 'standard Leyner drill-steel' is 1¼ or 1⅛-inch round steel; each drill-steel has two lugs on its shank, as shown in Fig. 1. These lugs, when the steel is shoved into the drill-chuck and given a fractional turn, serve to hold the steel in the chuck, both to facilitate rotation and in order that, if the steel gets stuck in the hole, the cranking back of the machine will extricate the drill. But some superintendents do not like these lugs, which, they say, are difficult for the blacksmith to make. To avoid the use of lugs on drill-steel for a mounted hammer-drill, hexagon drill-steel can be employed to insure rotation, as with stoper or sinker drills; this, however, necessitates a chuck somewhat different from the regular Leyner type. If the steel gets jammed in the hole, it is pulled out with a wrench; a sinker-drill, like the 'Jackhamer,' has a special 'puller' attached to it, being an ostentatious feature of that machine.

Drill-steel without lugs is likely to get pushed too far into the machine, injuring the efficiency by shortening the stroke of the hammer. To obviate this a collar is made on the steel, as shown in Fig. 2. This limits the distance that a steel can be pushed into the machine. However, one of the best methods is to use a tappet or anvil-block between the steel and the hammer of the machine; an additional advantage is that the anvil-block saves the hammer from becoming battered against the drill-steel.

E. M. Weston, in discussing South African drilling practice in the *Mining Magazine,* stated that "the whole theory of the design of rock drill bits as formerly expounded is wrong. The point most insisted on has been the necessity for allowing ample clearance between the wings of the bit for the ejection of cuttings." That is why the four-point cross-bit has been the standard for so long. It is now being demonstrated that the four-point cross-bit is by no means so efficient as more blunt bits properly designed to drill a rounder and more even hole while holding their gauge to better advantage. Hollow steel, as now used with hammer-drills, effects satisfactory removal of the rock chippings or mud by forcing water or air against the bottom of the hole. As Mr. Weston points out, "the more we make the bit into the shape of a piston with small openings for the escape of water and cuttings, the more violent will be the ejection of cuttings, which are thus not pounded up at all, greatly increasing the drilling speed," and again, "it

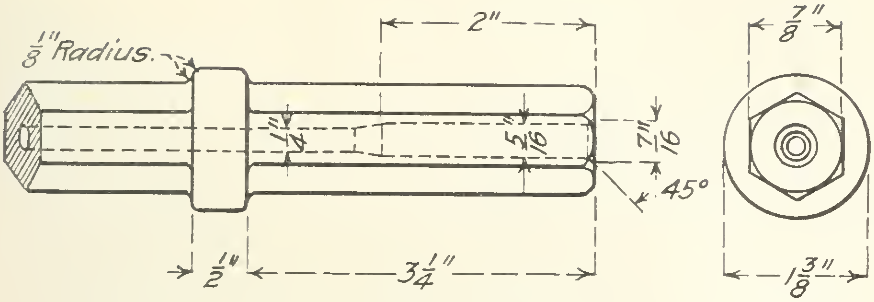


FIG. 2. COLLARED HEXAGON STEEL.

is quite feasible to use 1¼-in. steel with a hollow core of ½-in. diameter, or 1⅛-steel with ⅜-in. hollow core, such that the rock in the centre of the hole would be drilled around to form a core and broken off in large pieces, reducing the cutting necessary."

It does not require much perspicacity to see that the ordinary four-point cross-bit with its comparatively fragile edges soon dulls and wears away. This is where the new blunt-looking bits, such as the H and Carr, show to advantage. They hold their gauge much better than a cross-bit while drilling as fast or faster. The special feature of the design of the H-bit is its two parallel cutting edges, as compared to the one edge of the Carr bit. In the course of trials at the Gastineau mine, near Juneau, Alaska, two mounted water-hammer drills secured to a single cross-bar were tried with an H-bit of the International High Speed Steel Co. in competition with an ordinary cross-bit. The results showed a small advantage in the actual speed of drilling of the H-bit over the cross-bit, and a much greater advantage in not fitchering in bad ground. Furthermore the blunt and dull-looking H-bit did not require sharpening nearly so often, one set of steel out-drilling and out-lasting two sets of the cross-pointed steel. Variations of the chisel types of bits have their advocates, on account of the room allowed for the escape of mud. In reality the Carr bit is of the blunt-chisel variety, while the H-bit may be called a double-chisel type. However, while the simple chisel-bit may be effective in some rocks with hammer-drills, it has definite limitations particularly with piston-drills. That the introduction of improved drill-bits is a matter of no small consequence is indicated by a statement by James MacNaughton, general manager for the Calumet & Hecla Co.; he said, "the use of the one-man drill and Carr bit resulted in an increased out-put per miner equivalent to his total production of a few years ago."

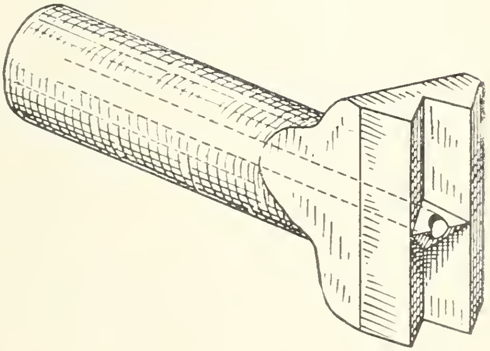


FIG. 3. H. BIT.

Regarding the so-called flat cross-bit—or low-centre cross-bit, which soon wears to the same shape—that is, with edges slightly flattened in proportion to the distance from the centre, it is clear that the additional metal in the wings makes reinforced edges that stand up to the work in hand, giving a stronger and more resistant bit than the ordinary cross-bit, because holding its gauge much longer. The whole idea is to get a bit that will not wear on the edges as quickly as the cross-bit; any method of reinforcing the peripheral edges, while not impairing the cutting speed or impeding the ejection of cuttings, is salutary, and represents the goal as at present recognized.—*Mining Press, San Francisco.*

Pennsylvania leads all other states in the country in the use of steam power, using twenty per cent. of all that is used in the entire United States.

GIVE THE COMPRESSOR A CHANCE

By Harry E. Scott.*

We hear many complaints about the inefficiency of air compressors, no matter how large or how small the mine or the compressor. This is not surprising when you take into consideration the fact that in many places the compressor while running only 6 drills has to supply enough air for 10, because of the loss by leaks in pipes and hose.

The leak being small, it is not believed that the loss is serious, so it is disregarded for a few days until the hole is so large that it has to be repaired. This takes just as much time as it would in the beginning, and is only done after a loss of air that should have been used to run the drills.

The majority of the small companies install a compressor just large enough to do the work at that time, which is proper; but as the mine progresses and more work is crowded on the machine by the installation of other drills, the compressor is overloaded and cannot do the work. Then the trouble starts—first with the most proficient of all kickers, the drill runner, then up the line it goes to the proper official, and he in turn goes after the machinery company. But is it the fault of the compressor? The foregoing is only one of the many reasons for poor air and the so-called inefficiency which, when investigated, are usually not the fault of the compressor, but due to the conditions found in most mines.

In the following paragraphs I will enumerate some of the causes for air losses that I have found in the mines of the West and Southwest in the many long years I have followed the game. Some of these offenses I plead guilty to in the days before I got the efficiency bird on my perch.

A CASE OF CARBONIZATION

Several years ago I went to an isolated camp on the desert. There was a small compressor that had been run by about 30 men, as near as I could find out, in the 1½ years it had been in use. The blacksmith would start it in the morning, and when he became tired, his helper would take his place. If they both had other work to do, a miner, mucker or a machineman who was not feeling well enough to go underground was put on for a few days to rest up. During the busy season, when none of these was available, or when stockholders were visiting, the superintendent or foreman would take a chance at it. The compressor was large enough to run seven drills the size they were using and keep 100 lb. pressure without getting hot.

At the time I arrived on the scene only three drills were running, carrying 60 lb. of air. You could fry pork chops anywhere on the compressor or motor. Taking advantage of a shutdown the second day on the job, I examined the cylinders and valves. It was a miracle that the receiver and the machine itself had not gone heavenward in small pieces. It was carbonized wherever possible for it to be so and I had to cut one of the outlet valves loose with a chisel. After a shift's work with two helpers, cleaning, filing and scraping, the compressor was started the next morning, carrying 80 lb. of air. The second day 90 lb. pressure was carried and the third day 100 lb., every part of both the compressor and the motor running as cool as any small high-speed machine. This compressor had been the source of much trouble between the mining company and the makers for months. This stopped when it was cleaned and given a chance to do its work.

This is not the only windjammer I have met in this condition. I have seen many of them, especially the smaller ones, which do not usually get an even break. The compressor is installed properly and run two or three months, when the compressor man quits. Of course a new one is needed and the superintendent has an old friend or the foreman has a brother-in-law who left home and the plow a few months before. The plow and grindstone are the only machines he knows anything about. He has worked underground a few months, mucking and carrying steel for the machineman and is a full-fledged miner now. It is pretty hard on the young fellow, so he is taken out of the mine and put on the compressor with the injunction, "Keep plenty of oil on it and you will get along all right." He uses about three times the oil he should, and in a short time the cylinders are running pretty hot. It needs oil, he thinks, so in goes a double dose and down goes the efficiency. I do not say the young man should not have a chance, but he should have been broken-in properly.

At one place at which I was employed there was much argument between the master mechanic's office and the mine department about the air. The mine men claimed they were not using as much air on the drills and air hoists as was being charged to them. I made some tests that surprised some of the bosses who had been letting the small leaks go. These drills and hose were taken out of the mine just as they were being used, with the same connections. On arrival at the shop the first test was made, and then repairs. After that a second test was made, and it showed where much of the disputed air, if not all of it, was going. These tests were made at 5,000 ft. altitude and one-minute runs.

---

*Morenci, Ariz.

	First Test			Second Test	
	Pressure, Lb.	Loss, Free Air, Cu.Ft. per Min.	Hose Repairs	Pressure, Lb.	Loss, Free Air, Cu.Ft. per Min.
	90	3.36	2 gaskets on connections	90	00
	95	105.29	2 gaskets on connections	90	6.95*
	90	42.00	2 small leaks	90	00
	85	38.75	1 small leak	90	00
			Air Drill Repairs		
Jackhamer	85	79.0	Cleaned and oiled.......	85	63.0
Stoper....	95	101.4	Cleaned and oiled.......	90	75.6
Piston....	90	182.0	Overhauled, leather.....	90	125.7

* This hose was full of small holes and could not be repaired, but by putting on two new rubber gaskets, over 98 cu.ft. of free air was saved each minute that the air was turned on, as it leaked just the same whether drill was running or not.

TESTS FOR LEAKS IN AIR CONNECTIONS.

These were not exceptional hose or drills, nor selected tests. They were the first we came to on entering the mine. The tests show enough air going to waste in the 4 hose to run 3 drills of the jackhamer type. If in fair condition, none of them need have been out of the stope more than 30 min. for repairs, but it seems to be the opinion of the modern shift bosses that it has to be "rock in the box" to pay dividends, regardless of how they get it. A drill or hose cannot lose time enough to be kept in condition; they do not consider the extra fuel at high cost which it takes to make this air that is doing nobody any good.

These things occur, not in one mine only, but in many of them—particularly the smaller ones, where the saving is more important than in the large dividend payer.

I do not believe that there is a superintendent who has enough fingers to count the leaks he sees or hears in the pipe lines on a single trip through a mine where a number of drills are working. The fault of the compressor and air drills is not with the makers so much as with the managers of the mine, who neglect the leaks in both the hose and the pipe lines and try to make a 10-drill compressor run 10 drills while throwing away enough air through leakage to run four more.—*Eng. and Min. Journal.*

SIMPLE PROCESS FOR PURIFYING MERCURY

Mercury which has been more or less long in service in a laboratory, gradually becomes contaminated by dust and dirt and amalgams of zinc, lead, copper, tin, etc., formed within it. It can be purified by a series of distillations in vacuum, which is a lengthy process, or by chemical methods (treatment with nitric acid), which takes still longer. We learn from *La Nature* that M. Margot, of Geneva has just perfected an old chemical process, which is both simple and effective. It consists in passing through the heated mercury a current of air which oxidizes the metals held in solution. The apparatus comprises an iron tube 1.6 meters long and 3 centimeters in diameter. This is held by two supports in a slightly inclined position. At the two extremities of the tube two tubular openings or necks are attached, one serving to admit air, the other to admit mercury. A Bunsen burner provides the heat required, which is from 150 to 160 deg. Cent. With this apparatus 10 kilogrammes of mercury can be purified in 24 hours. If a current of hot air is used the purification is said to be more complete.

What perhaps is the greatest pipe line in the United States is that running from the midway oil fields to Vernon, Cal., a distance of 153 miles of 8-inch steel pipe. The line has a daily capacity of more than 25,000 barrels.

SMALL DRILLS FOR A SMALL TUNNEL

By S. W. Symons.

One element of the new sewage-disposal system for Portchester, N. Y., is a tunnel 900 ft. long and 5x6 ft. in cross-section, in granite. In driving the tunnel, hand hammer drills were employed, mounted on the crossarms of a center column, as illustrated in Fig. 1. The drills were cleaned by water from the city mains. The advance averaged 200 ft. per month of 25 working days, the record month being 210.5 ft.

The contract for the tunnel was let to the Daly & Merritt Co., of Portchester. W. C. Brennan was Superintendent for the contractors and was responsible for the make-up of his organization and for the methods used in driving the tunnel. Borings were made along the line, and early in April, 1915, ground was broken with steam drills at the extreme southern point. The shaft was completed and the heading started on May 8, 1915, when the steam drills were discarded and mounted "Jackhamers" were substituted.

Air was furnished by a 12x12x16-in. Rand straight-line compressor taking steam from a 50-hp. portable Ames boiler. Steam pressure was 90 lb., the air pressure 80 lb. The air was led through a 1½-in. pipe a distance of 60 ft. to the shaft and thence to the heading. The capacity of the compressor was nearly double that required by the drills, with the result that it was run most of the time at only 88 r.p.m.—a little over half its rated speed.

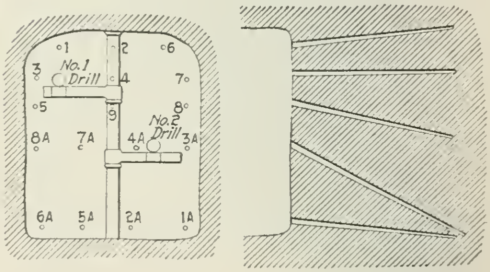
At the time of the writer's visit the tunnel had progressed 530 ft. northward, at which point soft ground was encountered; and it was decided to move the entire plant to the north end of the contract and drive back, in order to ascertain the exact extent of the soft material.

Fig. 2 is a diagram of the round. No. 1 drill, on the upper arm, puts in holes 1 to 9 in the upper half of the heading, and No. 2, on the lower arm, drills holes 1-A to 8-A. No. 2 drill, as a rule, has one less hole to drill than No. 1, owing to a more awkward position. Two drillrunners, a nipper and two muckers constituted the tunnel crew for each shift.

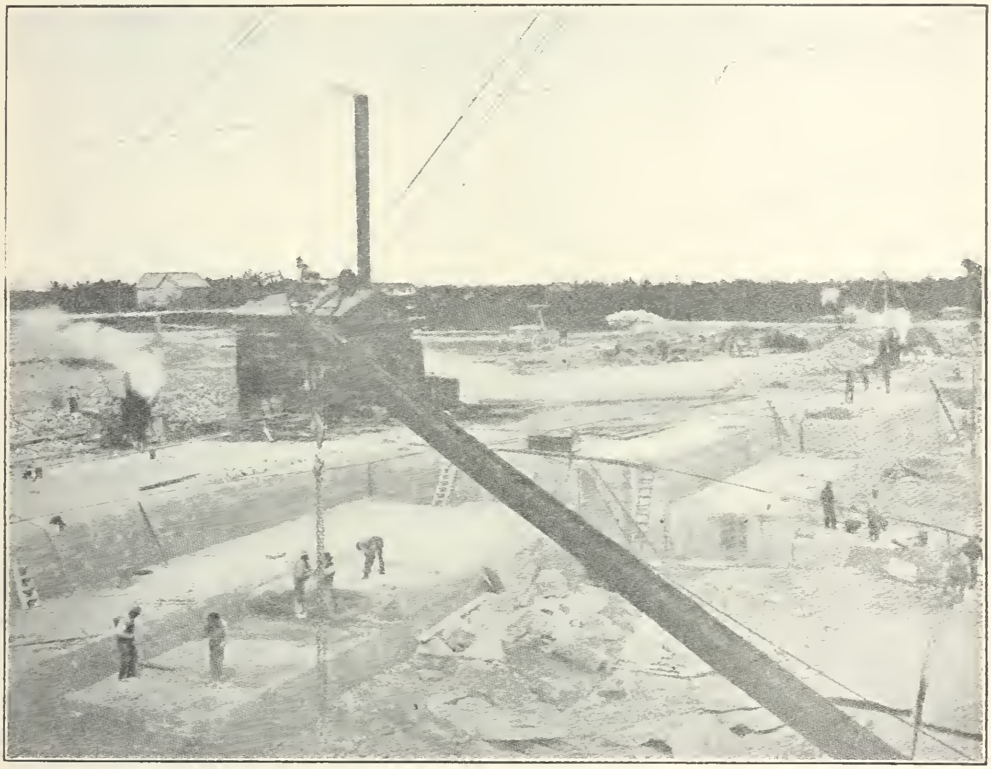
Holes 1-A to 8-A in the lower half of the heading were loaded first and fired together; then holes 5, 8 and 9 in the upper half and, lastly, holes 1, 2, 3, 4, 6 and 7. All holes were bottomed at 1⅝ in., 1¼-in. powder being used.

The average footage was 4 ft. per round, but when the tunnel broke high, allowing the use of a 6-ft. steel for holes 3-A, 4-A, 7-A and 8-A, as much as 5 ft. could be pulled. The total time for drilling the round, which included removing the heading muck far enough back to set up the drill column, amounted to from 4 to 5 hr., the loading and shooting consuming about 3 hr. Water, when encountered, was handled by a simple steam siphon. Drill steel was sharpened by hand. Crossbits were used.

Track was laid to within a few feet of the heading, to facilitate mucking operations. The muck was loaded into a bucket, set on a trolley pushed by hand to the shaft, the bucket hoisted to the top and the muck dumped close beside the shaft. A 2-drum hoist was used.



The powder used was gradually reduced to 10 lb. per cu. yd. of solid material—approximately 10 lb. per ft. of advance. The rock, for the most part, broke rather small for economical handling, but this was to be expected, owing to the small size of the tunnel and the necessarily close spacing of the holes. The dynamite was 60 per cent.—*Engineering News.*



FREESTONE QUARRY IN MANITOBA.

ANCIENT AND MODERN QUARRYING PRACTICE*

Any one who has contrasted the quarries of the old and the new world must have been struck with the difference in the methods used for operating them. Of course many of the European quarries were worked long before the perfecting of modern machinery, and consequently are more ragged and broken than would be the rule now. But still those that have been opened in comparatively recent years do not show the sharp and clean cut ledges and the level floors that mark most of our quarries. Nowhere else in the world can be seen the vast rectangular pits, descending floor after floor in regular steps, such as will be found in Vermont, New York, Georgia, Indiana, Ohio and other states, where the quarrying industry has assumed large proportions. In these quarries the stone is cut from its ledges by machinery, almost with the accuracy with which wood is worked, and with the minimum of waste. This, of course, is done by means of the channeling machine, and there is a minimum of waste, as this cuts a channel only two or three inches in width. Even in the hard stones like granite where the ordinary channeling machine cannot be operated, it is customary in most of the large quarries to get a smilar effect by the use of a rock drill mounted on a horizontal bar, and a broaching bit. By this means it is possible to quarry to dimension and so avoid the great waste that comes from a dependence on explosives alone. We have many times called attention to the fact that, for some reason the ordinary

---

*Abstract from *Stone.*

English and continental quarrymen cannot be induced to employ these machines, perhaps because they are an American invention. They have been demonstrated across the ocean but that they do all that is claimed for them seems to have no weight.

Perhaps it is an indication of a better spirit that one of the latest marble quarrying operations undertaken by Englishmen and financed by English capital, has introduced in its equipment the Ingersoll channeling machines. This is the enterprise that has already grown to considerable proportions on Marble Island, off the coast of Spitzbergen. Such appliances are very essential in these particular operations because the beds of marble lie flat and there are no open faces or ends. From the photographs of the deposits that we have seen, it would appear to be purely a channeling proposition.

In a large number of the British quarries the same methods are followed that were in use before the development of steam power. Where the beds have to be worked on two or more sides it is customary to dig trenches at least eighteen inches to two feet in width with hand picks so that wedges can be driven at the bottom. It needs no argument to show how wasteful and primitive this method is. One of the leading producers of a free working stone that is widely used throughout England for building purposes, is compelled to extract most of its stone from underground workings. Here would seem to be the place where channelling machines were imperatively demanded, the operations being conducted in a similar manner to the extraction of marble from the great underground quarries at West Rutland, Vermont. The actual method that is followed seems to be very crude and wasteful. Projecting pillars or buttresses in the various chambers are cut loose by handsaws. To give room for the workmen to ply their saws it is necessary first to pick away a considerable amount of good stone.

When we have spoken of the American quarries the reference has not been solely to those in the United States. Our Canadian brothers are enterprising and progressive and some of their quarries are models of equipment. The accompanying illustration of a big freestone quarry in Manitoba makes striking appeal in these days when the watchword is "efficiency." One does not have to know much about quarrying methods to realize that here the stone is extracted in the most effective manner and that there is no unnecessary waste. Of course the deposit is admirably adopted for quarrying operations but it is certainly not unique in this respect. We venture the assertion that nowhere except in America, unless it be in Belgium, can one find a stone deposit worked in so satisfactory and efficient a manner.

While we have made these efforts to eliminate waste and useless cost in most lines of quarrying, an exception must be admitted in the case of the slate industry. Here there has been scarcely any improvement and the waste is almost prohibitive. The vast mountains of refuse in all of the slate centers are not only a terrible disfigurement of the landscape and the cause of much expense to all operators, but they frequently prevent the possible development of the business. Owing to the nature of the stone and the formations it would be impossible ever to reduce the percentage of waste as low as in the quarrying of a structural or decorative stone. Still much could be accomplished if a close and thorough study were made of all of the problems of quarrying and dressing slate. Instead of this, the operators cling to the out-worn methods of their forefathers and seem actually to resent any innovations.

Perhaps one reason that will account for this is that the great majority of the quarryman are Welshmen, with all of the conservatism that marks the Briton. A peculiar fact must be noted here; the slate quarries of North Wales are operated in a more progressive manner, as a rule, than the stone quarries. Doubtless the reason for this is that many of them are worked by their wealthy owners, and trained engineers are put in charge.

COMPARATIVE EFFICIENCIES OF COMPRESSORS AND BLOWERS

In *Engineering News* of Nov. 4, 1915, in discussing air compressors for activated-sludge tanks, Carl H. Nordel, engineer of design of the Milwaukee Sewage Commission, gives the following summary of efficiency of various types of compressors for low and medium-pressure services—such as are used in smelting and converting operations.

The mechanical efficiency of the reciprocating compressor, as ordinarily measured by comparing the work done in the steam and air cylinders, is usually in the neighborhood of 85 to 90 per cent. The higher the pressures it is necessary to employ the more this figure will be reduced. The older types of compressors are less efficient than the later ones. The introduction of large thin-plate valves has reduced air velocity through ports and cut down the heating at this point. The higher the pressures the hotter are the cylinder walls—even with good cooling systems—and the greater is the reduction of air taken in for compression. Tests on plants in operation show that such losses in compression may perhaps be 25 per cent. (besides the 10 or 15 per cent. mechanical losses mentioned) for the higher pressures.

The first cost of reciprocating compressors is comparatively high, and they are bulky in proportion to their output. They may be had in any capacity from less than 100 cu. ft. per min. to the large blowing engines of from 40,000 to 50,000 cu. ft. per min.

LIMITATIONS OF THE TURBO-BLOWER.

The turbo-blower is a comparatively recent development. It is substantially a turbine pump. The pressure is secured by imparting a high velocity to the air, with a subsequent transformation of the velocity head into pressure head. Water weighs about 800 times as much as air; hence to secure the same pressure rise per stage with a blower as with a pump, the velocity would have to be 28 times as great. In consequence the rotative speeds are usually carried as high as safety will permit. The impeller tips are sometimes run at 600 ft. per sec., when as much as 3 to 4 lb. pressure can be secured in a single stage. Ordinarily, however, 2½ lb. is considered the limiting pressure per stage.

These blowers are well adapted to handling large volumes of air. Being high-speed machines, they are compact and comparatively inexpensive for their capacity. The larger units show a good efficiency, often reaching 75 per cent.; but the efficiency falls off with the size. Driven by direct-connected steam turbines, excellent overall economies are secured. The guaranteed steam consumption for units delivering in the neighborhood of 30,000 cu. ft. per min. is as low as 15½ lb. of steam per hour per air horsepower.

The steam-turbine-driven units have a flexible delivery, even at constant pressure, and by slightly varying the pressure high efficiencies over a large range of deliveries can be obtained.

A complete line of turbo-blowers direct-connected to high-speed motors and delivering from 2,000 to 40,000 cu. ft. per min. has been developed. Variable delivery at constant speed over a fair range, without too great loss in efficiency, can be secured by throttling the discharge and intake.

Positive-pressure blowers operate on the same principle as a rotary pump. Lobed impellers meshing with each other in a manner similar to the teeth of a gear revolve within a casing, sweeping the air before them. The impellers do not quite touch each other or the casing and there are consequently clearance spaces through which some of the compressed air leaks back. With well-made blowers the clearance is small and the leakage fairly low.

The amount of leakage is constant so far as the speed of the blower is concerned, but varies with the square root of the pressure. Hence these machines become less efficient as the pressure is increased, and this tends to limit their use generally to pressures below 10 lb. The leakage or slip is measured by the number of revolutions of the blower required to make it good. Thus, if the slip is 100 r.p.m. and the speed of the machine is 500, the volumetric efficiency is 400 r.p.m., or 80 per cent. The capacity of the machine is usually stated in terms of the displacement per revolution, and the delivery is equal to the displacement multiplied by the rotative speed minus the slip. Obviously, the higher the speed the better is the efficiency.

The losses other than slippage are small. Probably 5 to 10 per cent. would cover all losses outside of slippage.

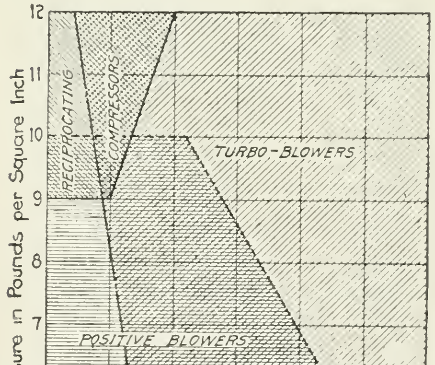
As the intake port is very large, the air is not heated on entering the blower, and thus a good volumetric efficiency is assured. Efficiencies based upon the power input range from 60 to 85 per cent.

The positive-pressure blowers are comparatively slow-speed machines, ranging from 600 r. p. m. in the small sizes to 100 in the larger.

The positive-pressure blower is not well suited to a variable delivery, as the efficiency falls off with the speed.

There is another type of compressor that possesses peculiar interest—the Taylor hydraulic compressor, which has been so successfully installed in some mining districts.

This apparatus uses the weight of falling water to compress the air without the application of any intervening machinery. The water is allowed to fall through a shaft and in doing so it sucks in air through a large number of small pipes and entrains it in small bubbles, which it carries to the bottom of the shaft. After descending far enough to secure the required pressure, the mixture of air and water is allowed to flow horizontally, whereupon the air separates out and fills a reservoir from which it is drawn as needed. Excellent results have been obtained with several installations, notably at the Vistoria mine, Michigan, and at Cobalt, Ontario. The former compresses 36,000 cu. ft. per min. to 128 lb. gage pressure with an efficiency as high as 82 per cent. This remarkable showing is explained in part by the fact that the compression is absolutely isothermal, the water absorbing all the heat as rapidly as it is generated.



LIMITS OF EMPLOYMENT FOR DIFFERENT TYPES OF BLOWERS.

The accompanying diagram gives about the economical range for three familiar types of blowers if the delivery is to be nearly constant, though such a diagram can naturally be only approximate.

COMPRESSORS DOWN IN THE MINE

By Charles C. Phelps.

Until quite recently it has been rather unusual practice to install compressors underground in mines. Undoubtedly there have been many instances where local conditions would have dictated such underground compressor installations had units wholly suitable for such service been available. Many compressors, as made at the present time, both portable and stationary units, are well adapted for underground service. The advantages of the portable type have been appreciated particularly by the coal mines, where many such plants are in use.

Under certain local conditions a permanent underground stationary plant has been found to possess certain unique advantages. One of the first mines to apply these advantages was the Humboldt mine, Ouray, Colo. Over 3 years ago this gold mine installed in a cavity cut out of the rock in the mine an Imperial "XB-2" compressor, short belted to a 150-hp. Fort Wayne motor. The primary reason for placing this unit underground was to avoid the difficulties encountered with snow slides. The compressor was placed 1200 ft. from the portal of the tunnel in order to reduce the length of pipe line to the drills. The compressor has a 16-in. stroke and the 2-stage cylinders are 20 and 11 ins. respectively in diameter, giving a piston displacement of about 850 cu. ft. per minute at 150 lbs. pressure. This compressor is installed at an altitude of 12,000 ft. It is a standard machine, excepting that shipment was made with frames split, and the whole compressor was knocked down to facilitate handling in the limited space of the tunnels. A comparatively small amount of rock had to be excavated in order to permit the installation of the machine, as the unit was exceptionally compact, due to the short belt drive. A better idea of the suitability of this type for underground use will be gained from the description of it given later. Barely enough room was left around the machine for the passage of the attendant.

At the Mount Champion mine in the Leadville district, there is a similar installation, also placed underground principally to avoid trouble with snow slides. This property is located about 13,000 ft. above sea level on a steep

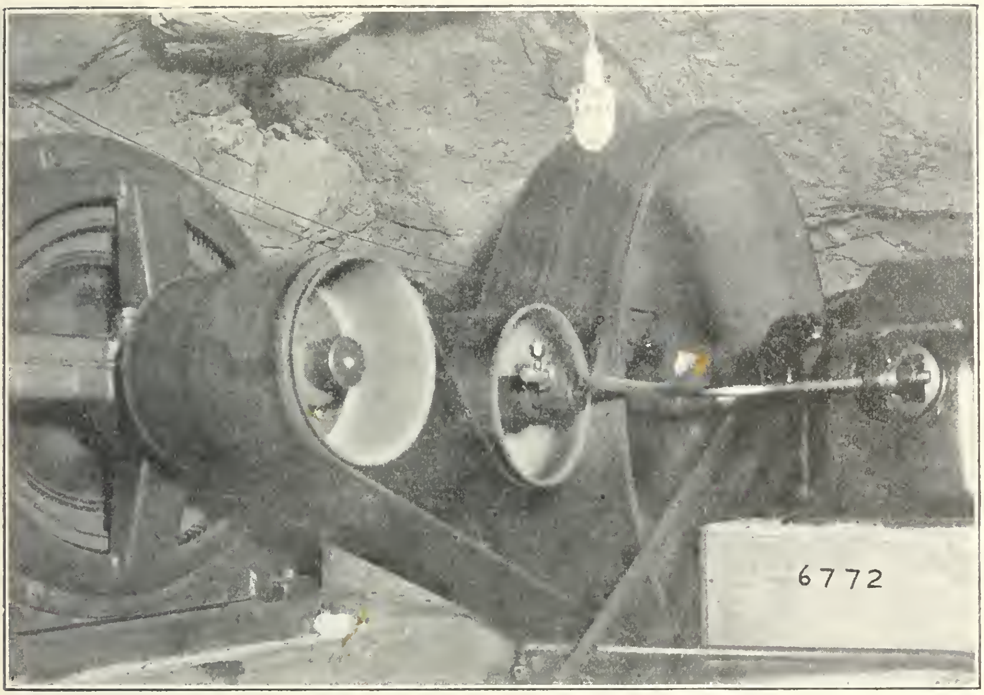


FIG. 1. THE SHORT-BELT DRIVE AT THE RAINBOW LODE DEVELOPMENT CO.'S PLANT, BUTTE, MONT.

barren hill. This compressor is an Imperial "XB-2" with a stroke of 14 ins., cylinders 18 and 10 ins. diameter and is driven through short belt-drive by a 100-hp. General Electric motor. The piston displacement is about 750 cu. ft. The outfit is located about 75 ft. from the surface and is used for operating drills. This equipment was also shipped knocked down, and as little rock as possible was excavated to accommodate it.

At the Wilkeson Coal & Coke Co.'s mine at Wilkeson, Wash., there is a smaller unit installed underground — an Ingersoll-Rogler Class "ER-1" straight-line compressor, short belted to an electric motor. This plant is about 1½ miles from the entrance to the mine. The compressor has a 12-in. stroke and 14-in. diameter cylinder, with a piston displacement of 464 cu. ft. per minute.

It is probable that in each of the above cases a compressor with an ordinary belt drive would have been out of the question, due to the great expense that would have been involved in removing sufficient rock to accommodate it. The Humboldt mine compressor plant, for instance, has an over-all length of about 19 ft., an over-all width at the compressor end of 10½ ft., and a height over the flywheel of about 8 ft. A corresponding unit of the ordinary long belt type would have the over-all length increased to about 40 or 45 ft. The over-all length of the Wilkeson plant is about 17 ft., the width about 4½ ft. and the greatest height about 6½ ft. A corresponding unit of the ordinary long belt type in this case would have the over-all length increased to about 35 ft. The compactness of the short-belt type is exceptionally well illustrated in Fig. 1.

In addition to the exceptional compactness of the short-belt compressor, the enclosed construction, preventing the entrance of dirt and dust to the working parts, and the automatic oiling system well fit this type for underground service.

There are other advantages to the short-belt drive besides compactness. Increasing the initial tension in a belt increases the pressure on both motor and compressor pulleys, increasing the frictional resistance and converting into heat a certain amount of the energy, which is thereby lost to any useful purpose. It also decreases the life of both belt and bearings. On the other hand, leaving a

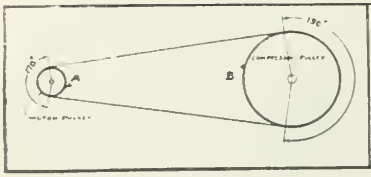


FIG. 2.

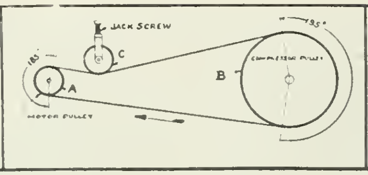


FIG. 3.

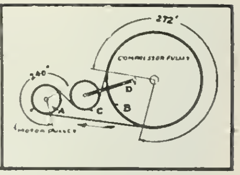


FIG. 4.

belt loose permits excessive slippage of the belt on the pulleys, which also greatly lowers efficiency. It is obvious that the greater the arc of contact of the belt on the pulleys the less will be the slippage. For that reason it is customary, when employing the long-belt drive, to place the motor and compressor pulleys sufficiently far apart to ensure a reasonable arc of contact. From Fig. 2 it is apparent that the belt contact on the motor pulley is none too much, but is about all that can be obtained by this arrangement. Fig. 3 shows how a stationary idler pulley is commonly applied when belt slippage is experienced with the arrangement of Fig. 2. Although overcoming the slippage problem, this only re-introduces the tight-belt evil. In the short-belt device, illustrated in Fig. 4, C is an idler pulley which is carried on arms swung from the compressor frame at D. Thus instead of being fixed in position, it "floats" on the belt, and is free to rise and lower. The short belt drive, illustrated in Fig. 4, has practically zero initial tension, as the weight of the idler is very small. As soon as the motor starts, tension increases in the lower side of the belt, the upper, or slack side, lengthens and the idler pulley lowers, taking up the slack, and at the same time wrapping the belt farther around the driving pulley, giving a greater arc of contact for the greater power transmitted, the scientifically correct arrangement. Greatly reduced belt and foundation costs are additional advantages of this type of drive, applying equally to underground and above ground installation.—*Min. and Eng. World.*

Among the "safety first" slogans of the Inland Steel Co. are the following:—"Any fool can take a chance; it takes brains to be careful." "When hurry interferes with safety, cut out the hurry." Cutting out the hurry is essential not only for safety, but also for efficiency.

A NEW TYPE OF VACUUM PUMP

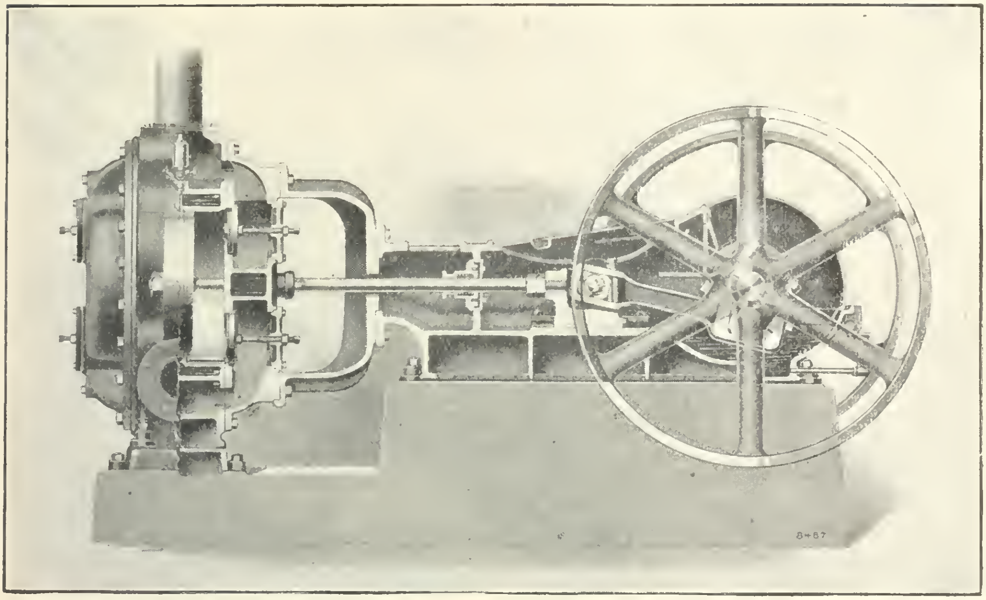
The Ingersoll-Rand Company has recently placed on the market a new dry vacuum pump, the "Ingersoll-Rogler." This type of machine has been developed, from the Company's line of straight line air compressors, for condenser service and other duties requiring the maintenance of a high vacuum.

These machines are of the horizontal, center-crank type and are built both steam and power driven. A feature, pointed out by the maker to be a marked improvement, is the substitution of an automatic lubrication system for the usual grease cups found on machines of this kind. Removable cast covers prevent the lubricant from escaping and, while affording quick access to all parts, completely exclude dust and grit.

The vacuum cylinders are fitted with "Ingersoll-Rogler" valves, a type which has proven highly satisfactory in air compressor service. They are automatic in action. These valves are of the multi-ported plate type and are featured by ample port opening with very slight lift. It is also to be noted that these valves need no lubrication. Inlet valves are placed in the top and discharge valves in the bottom of the cylinder heads, which construction provides for the immediate discharge of any liquid entering the cylinder. Water jacketing on both cylinder barrels and heads is said to increase the efficiency by keeping down the heat generated in the vacuum cylinders.

The power driven machine (Class "ER") is often furnished with short-belted electric motor as a complete unit, as well as with plain belt wheel for other drive.

The steam driven type (Class "FR") has a balanced piston steam valve which permits its operation on high pressure and with superheated steam. Both vacuum and steam cylinders are lubricated by a force feed lubricator. These Class "FR" machines are furnished with a continuous sub-base under the entire unit.



NEW VACUUM PUMP.

Due to the high operative speeds, permissible with low lift plate valves of the "Ingersoll-Rogler" type, it has been possible for the manufacturer to so increase the capacity of a pump of a given size that in comparison with equal capacity machines of the old type the floor space occupied is reduced to a marked degree. This saving is said by the Ingersoll-Rand Company to be about two-thirds.

"Ingersoll-Rogler" Vacuum Pumps range in capacity from 292 to 2295 feet per minute and are guaranteed by the manufacturer to maintain a vacuum of within one-half inch of barometer against a closed intake. They are also capable of handling discharge pressures of several pounds.

COMPARISON OF "ECONOMIES" IN OFFICE AND MINE

BY LETSON BALLIET.

The other day I was in the office of the manager of one of the large mining companies of the west. I noted that the office was furnished with golden oak furniture, an elaborate system of filing cabinets, an expensive adding machine, two fine typewriters, a check writing machine, an addressing machine, with every detail of office equipment modern and up to the minute.

While I was in the office, a salesman for one of the typewriter companies called, and after some talk, made arrangements to take the two perfectly good typewriters at $40 apiece in exchange for two new writing machines, requiring $65 cash payment upon each of the new machines.

An hour later a salesman representing a pneumatic rock drill called to explain the merits of a new and improved model. The manager showed but little interest, and finally dismissed the salesman with the remark that "I don't need any new drills right now; the old ones are giving good service yet."

After the salesman had left, I evidently showed that I was amused at something, for the manager inquired "what are you smiling at?" "Not much," I said. "I was just wondering why you didn't tell that typewriter salesman the same thing that you did the drill man—and say, 'I don't need any new typewriters right now, the old ones are giving good service yet.' "

He was relieved from the embarrassment of answering by the entrance of the mine foreman at that moment. There was some conversation about a mine pump that I couldn't hear, till the foreman lost his temper and said in a loud voice, "the d—n thing is always giving trouble, and we lose two or three hours every few days monkeying with it, and doctoring it up." To which the manager replied, "I'll send Smith (a machinist) down to fix it up.' I smiled again, as the manager returned to me, and I asked him: "Why don't you cancel the order for those two typewriters and buy a new pump? It seems to me that you could make more money for your company, saving the time and worry on that pump, than you can in changing typewriters in this office. You are losing $20 every time that pump hangs up your work for two or three hours, and it wouldn't take long to save enough to pay for a new pump."

The shot went home, so I followed it up with this question: "How many men have you on the payroll of the mine?"

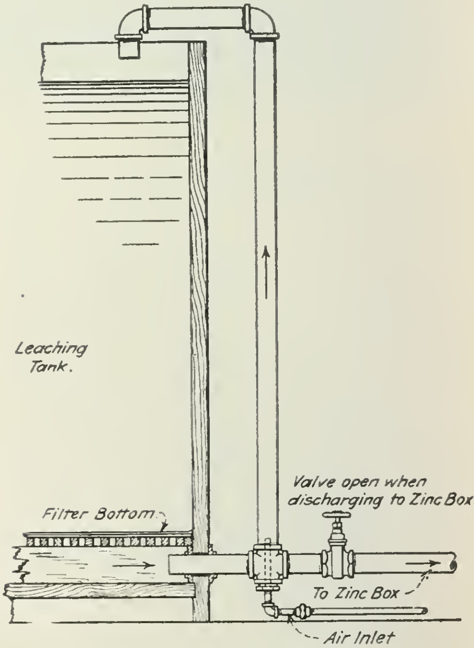
"Eighty-two," he replied.

"How many are employed in this office?"

"Two besides myself."

"Now tell me," I said, "why is it that you think you are an efficient mine manager when you have everything from office furniture to inkstands brought up to the very latest models in efficiency for the use of *three employees,* while you force *eighty-two* employees of the same company to work with old wornout and obsolete drills, a second-hand pump that was about worn out when you put it in the mine, and pipe lines that are leaking more compressed air to waste than you use. You want the finest tools for your office work, yet your men are working with rusty handsaws and axes with cracked handles, the cheapest shovels and picks that you can buy. You want 14 electric lights in this office (I counted them), with big tungsten globes, and expect your miners to do efficient work with defective tools in the light of a candle. More than that you have dozens of pen holders in this office and plenty of everything else; and I saw a note hanging in the foreman's office this morning, where it had been left by the night foreman, which read: 'What became of those two wrenches that were on the 1200-ft. level?' I noticed that the day foreman brought two new wrenches out of the storehouse and sent them down on the first cage; but how would it sound to ask: 'What became of those two pen holders that were in the office yesterday? You'd think you were losing money if a couple of office clerks couldn't find pen holders, but you don't think it costs anything for twenty or thirty men on the 1200-ft. level to be working with 'two wrenches,' while the night shift couldn't get any new ones till the day foreman came to open the storehouse."

If this was the only time I had ever noticed similar conditions I wouldn't say a word about it, but in the last twenty years I've been in a good many mines and mine offices, and I have the first one to see where something on this order wasn't to be found. How a mine manager can think he is efficient, with a showy office equipment, and $25,000 monthly expense to do work that $10,000 ought to do in the mine, is more than I can understand. There isn't one mine manager in a hundred who could *get by* in a big factory with this method. —*Min. and Eng. World.*



AIR LIFT HASTENS LEACHING

While leaching seems an old-fashioned subject, there are a great many plants in which the leaching of the sand is carried on with the agitation of the slime, so even at this late date, it seems to me, suggestions on the improvement of this phase of cyaniding are not out of place.

The Zopilote mill in Tepic, Mexico, was of this type. In order to increase the capacity of this mill, without additional equipment, it was necessary to increase the proportion of sand to slime in the crushing department and, to handle this increased tonnage of sand, the time of leaching had to be cut down. I accomplished this by the introduction of air-lifts in the solution-discharge of the tanks, as is shown in the sketch. In this way the solutions were kept in constant motion in the tanks and a freshly aerated solution was continuously supplied to the ore with a surprisingly small consumption of air, the lift being less than a foot and the total length of the column being less than seven feet.

This simple arrangement cut down the time of treatment 33 per cent. with an increased extraction and, at the same time, cut down materially the zinc consumption, as the solutions were not precipitated until they were much richer than under the old system.—*Clark Sullivan in Mining Press.*

ATMOSPHERIC PRESSURE AS AFFECTING HEALTH AND COMFORT*

From the multitude of problems recently presented, the one considering the relationship between air pressure and health appears now to be the most popular. There is considerable misconception regarding this subject occasioned primarily by confusing effect with cause. The mere change in atmospheric pressure from day to day has nothing whatever to do with one's physical well-being. The recent publicity given to this subject during the last few months is simply a revival of a myth laid a generation ago by Thomas. For example, in a recent public bulletin it is stated that when the barometer drops from 30 to 29 inches from one day to the next the human body is relieved of half a ton of atmospheric pressure, with resulting depression of spirits, etc. In the first place, it is quite unusual for the barometer to drop one inch in so short a time, and in the second place, experiments have proved that the influence on the body of variations in pressure is greatly overestimated.

Hann quotes Thomas and says that in experiments with pneumatic chambers, pressure changes amounting to 300 millimeters (over 11 inches in barometric values) a day have been produced without causing any injurious effects on the sick persons concerned in these experiments. Although these experiments were made nearly half a century ago, the pressure myth has persisted, and even this year has found its way into sober-minded periodicals. If a local example is needed to demonstrate further the untenability of the pressure theory, we have only to recall that in Los Angeles, for example, the range of the barometer from day to day averages a tenth of an inch of the mercurial column, equaling the variation experienced when riding in an elevator from the ground floor to the top of office buildings. If there was anything in this theory we would have an "elevator disease" among the elevator conductors who continually experience excessively rapid fluctutations in bodily pressure.

HUMIDITY HAS MORE EFFECT THAN PRESSURE.

It is rather the fair weather and decreased humidity which accompany rising barometric pressure that elevate one's spirits, or the cloudy threatening weather and increased humidity which accompany a falling barometer that affect the human system. Dr. C. C. Browning noted this when his studies showed that the tuberculosis patients became pessimistic and some very unreasonable in their demands during days with little or no sunshine and hopeful of recovery during bright days and moderately low humidity.

SUNSHINE AND AIR MOTION MOST IMPORTANT.

I believe that the location of the home or office, the exposure of the living or work room has more to do with the health of the occupant than whether or not the relative humidity is much below or above normal. Exposure to sunshine and ample ventilation are all important. A friend complained of ill health and blamed the humidity of his office room. He said that it was too damp and asked me to investigate. I took my psychrometer and made a series of observations, finding that there was actually less humidity in his private office than out in the street. I studied the situation and eliminated temperature, humidity, air pressure, etc. Then I turned to air movement, and found the ventilation very bad. I suggested a simple air changing system and my friend regained his health in a few weeks, and was still enjoying his private office when I last heard from him.

---

*From a paper by Ford A. Carpenter, LL.D., before American Climatological and Clinical Association.

AIR DRAINAGE.

Facing houses with relation to natural air drainage is a most important point in selecting a home. Many a home, otherwise healthful and satisfactory in every other respect, has been abandoned because the architect and owner did not consider the principles laid down by Hippocrates two thousand years ago.

POWER COST OF AIR LIFTS

Charles Legrand, of Douglas, Arizona, consulting engineer for Phelps, Dodge & Co., at the San Francisco meeting of the American Institute of Mining Engineers, discussed the characteristics and qualifications of the various types of pumping apparatus employed for the unwatering of mines.

Of the air lifts he spoke as follows:

As to air-lifts, these are inexpensive to install and will handle large quantities of water in a small space, where proper submergence can be obtained. The method could not be used from the lowest level of a mine without a lot of complications, as there is no way to get the proper submergence. Although air-lifts require a good deal of air, the other running costs are almost nothing. Air-lifts were used at the Old Dominion mines at Globe during a recent emergency. Two 10-inch air-lifts, raising the water 200 ft. and 431 ft. respectively (excluding friction) taking air at 90 to 95 lb. (at the power-plant) required the following amounts of air (measured by flow-metre) at a barometric pressure of 27 in. of mercury, the submergence in each case being 190 feet.

Gal. per min.	Cu. ft. free air per min.	Cu. ft. free air per 1000 gal.	Steam consumption.
1680	1809	1080	48.7
1794	2262	1261	57.5
1122	3051	2718	57.0
1233	3395	2753	57.6

The steam consumption per water hp.-hr. is based on air-compressors requiring 38 lb. of steam per 1000 cu. ft. of free air, delivered compressed at 90 lb. gauge-pressure.

BOILER EXPLOSIONS IN GERMANY

In the entire Empire of Germany, not including those used in the military and naval service, there were, in 1914, only eight explosions of steam boilers. One of these was built in 1873, one in 1874, one in 1880, one in 1881, one in 1892, one in 1902 and two in 1906. The dates are mentioned as showing that all the boilers were well along in years; the most were of the last century. Low water is given as a probable cause in five out of the eight cases. In three of the explosions no personal injuries were caused. The other five killed two, seriously injured two and slightly injured seven persons.

In the same period there occurred in the United States 575 accidents to boilers, by which 300 persons were killed and 476 more or less seriously injured; and yet there are those who protest with all of the outraged righteousness of American citizenship imposed upon against any governmental control or supervision of the design and operation of boilers, or of the competency of the men that run them.—*Power.*

A NOVEL CONSTRUCTION FOR GAS HOLDERS

The floating bell form of gas holder, with its telescoping sections, water tank seal for the lower edge and elaborate framing for guiding the cylinder, is a very expensive structure, and it has not been evident how it could be improved. A new principle has, however, been devised that greatly simplifies the construction and reduces the cost. Instead of being movable the tank is fixed, and its roof is movable, sliding up and down within. This roof is fitted as closely as possible, and to prevent the gas escaping water is pumped onto it, thus forming a water seal. Of course some water passes through the joint, but this is withdrawn and returned to the roof by a pump regulated to compensate for the leakage.

A FACTORY PERISCOPE

The men in the fire room of a factory cannot always tell, without going outside to look, whether the chimney is smoking, and this is important, both as a matter of economy in burning the coal, and also to enable them to conform with smoke regulations. A writer in *Power* suggests placing a mirror outside the building and setting it at such an angle that the men, looking out of the window, can see the reflection of the top of the stack in the mirror. In some cases, where one mirror cannot be properly located, two might be used for the purpose.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE
Compressed Air Magazine Company
Easton, Pa.
New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. APRIL, 1916. No. 4

CONTENTS

Morningside Park Pumping Problem .. 7939
A Big Little David 7944
War Destroys Quarries 7944
Cooperation of Engineers with the Government 7945
Drill Shanks and Bits 7946
Give the Compressor a Chance 7948
Small Drills for a Small Tunnel 7950
Ancient and Modern Quarrying 7951
Efficiencies of Compressors and Blowers 7952
Compressors down in the Mine 7954
New Type of Vacuum Pump 7956
Air Lift Hastens Leaching 7958
Atmospheric Pressure as Affecting Health 7959
Power Cost of Air Lifts 7960
William Sooy Smith 7961
Brasher Compressed Air Breakwater .. 7962
East River Tunnel Blowout 7962
Alloy Steels 7963
Bureau of Mines, New Publications ... 7963
Vacuum Transportation of Dust 7963
For Industrial Preparedness 7964
Notes 7965
Patents 7967

WILLIAM SOOY SMITH

General William Sooy Smith—or, as frequently written, Sooysmith—who died at Medford, Oregon, March 4th, had a national reputation as a foundation specialist, especially in his development and wide employment of the pneumatic caisson. He also successfully employed the freezing process in excavating for foundations in water-bearing strata.

He was born at Tarlton, Ohio, in 1830 and after the usual common school experience received his professional education at the United States Military Academy at West Point, serving in the army a year after his graduation. There being little of interest doing in the army at that time he resigned to engage in engineering work on the Illinois Central Railroad which was then being rushed for the rapid development of the State. Then he became assistant engineer to the U. S. engineer in charge of the improvements in the harbors of Lake Michigan, from which position he was compelled to resign on account of ill health. In 1857 he was appointed to the responsible position of chief engineer, age 27, on the construction of an iron bridge across the Savannah River for the Savannah & Charleston Railroad.

At the beginning of the Civil War he was a colonel of infantry, distinguishing himself on many occasions and successively rising until he attained the command of a division and became chief of cavalry under Gens. Grant and Sherman in the military division of the Mississippi. His strenuous life and exposure brought him near to death from inflammatory rheumatism and being incapacitated for further service he resigned.

After having sufficiently recovered his health he resumed practice as a civil engineer in Chicago, and did work both as engineer and contractor for the U. S. Government and for the railroads. An epoch making job was the reconstruction of the Waugoshanee lighthouse at the western entrance of the Straits of Mackinac, for in the construction of the heavy sea wall around the lighthouse he used his first pneumatic caisson and so far as known the first used anywhere. In this period also he built the first all steel railroad bridge in the world at Glasgow, Mo. and the substructures of six other bridges by the pneumatic process. He completely changed the methods of constructing the foundations of heavy buildings in Chicago, carrying the loads down through mud and soft earth to hard bottom 50 feet or more by means of piles cut off below the water surface. In some cases to avoid danger to adjoining buildings columns of solid concrete were sunk to hard bottom and the buildings were erected upon them.

In this brief sketch we have followed principally the obituary of the Engineering Record. It will be gathered that Gen. Sooy Smith was probably the leading authority both in theory and practice as to all the means and methods employed in the building of foundations, and his various achievements in this line were examples to be followed, often of course with successive improvements, by the advanced engineers of the world. It is not easy to realize what a prize to engineers was the pneumatic caisson, and still more difficult to find out what we could do without it. The special habitat of the pneumatic caisson would seem to be downtown New York City, where the surface of the primeval rock is at such a level below tide water, with a porous soil above it, as to supply the precise conditions where the caisson applies. If the rock surface were fifty feet higher, as it is farther uptown, the caisson would be superfluous, and if the rock were fifty feet lower the use of the pneumatic caisson would be impossible as the pressure would be beyond the endurance of the sandhogs. As it is, we have such a building as the Equitable or the Bankers' Trust, the superstructure-supporting, water-excluding foundation of which is a continuous pneumatic caisson, concrete filled, all around the enclosure, with sufficient piers distributed over the area within to carry the enormous weight with an absolute and enduring safety never exceeded in the world.

THE BRASHER COMPRESSED AIR BREAKWATER ON THE PACIFIC COAST

This device, which has more than once been described in our pages, proposes to overcome the violence of breaking waves along the coast by the discharge of compressed air up through the water from submerged pipes paralleling the shore line. Sufficient exhibitions at points on the Atlantic coast have been given to demonstrate great possibilities of success if adequately installed, and now we have information of another most encouraging trial at El Segundo in the neighborhood of Los Angeles as narrated in local papers of recent date.

When the heavy storms struck the coast of California last year 2000 feet of the Standard Oil wharf was destroyed and washed out to sea, and to prevent similar destruction this year the Brasher system was tried, though only in a small way, and the wharf at El Segundo stood intact in spite of the powerful waves. Air pipes were laid 145 feet out from the end of the wharf covering an area 120 feet wide, and two other pipes, each 100 feet long extended out from the sides of the wharf. When the storm arose the compressor on shore, working continuously, sent the air through the pipes and it escaped through the small perforations and was distributed in bubbles through the body of water, thus contributing an elastic element which entirely transformed the action and effect of the wave movement.

The device should be of great practical value in connection with engineering operations in exposed situations. According to Mr. Brasher: "It would do away with breakwaters and seawalls, would protect coffer dams, and would permit dredging and salvage operations in all sorts of stormy weather. Dredges could be kept working in the most exposed places during the roughest weather. The erection of permanent breakwaters, piers, lighthouses and dams might be continued steadily, no matter what the weather conditions. Half completed structures might be protected until finished. Lightships could ride out the roughest gale in an artificial lagoon of calm sea. Stranded vessels could be protected from the pounding of the waves until floated. It would permit the coaling of ships at sea under any conditions. With it soldiers might land on a hostile shore when the sea was at its roughest."

AN EAST RIVER TUNNEL BLOWOUT

There are now being driven through the soft and treacherous material under the East River four tunnels—two pair—for additional passenger traffic lines between Manhattan and Brooklyn. The difficulty and danger of the work are now sufficiently well known, so that the work goes on without public mention unless some unusual incident occurs.

A serious and fatal blowout occurred Feb. 19 in the north tunnel of the South Ferry—

Montague St. subway. The tunnel is being driven by the usual shield method, and had reached a point about 600 ft. from the Brooklyn shore. The excavation had proceeded apparently under a pocket or depression in the mud, leaving a very thin spot with 24 lb. air pressure beneath it. The shield in the heading was about to be driven forward by hydraulic pressure another step of 26 in., and for this purpose the shoring in the excavation was being removed by two sandhogs when a hole began to open in the roof in front of the shield. One of the men tried to plug the hole with a bag of sand, but was forced up into the water of the river, and immediately the two men also who were removing the shoring were blown up through. One of the three men was rescued from the river alive. As the hole enlarged water entered the tunnel until it was flooded. Work was immediately resumed, the first operation being the dumping of a large body of clay over the thin spot in the river bottom. A blowout of similar character occurred on Nov. 30 in one of the other pair of tunnels.

ALLOY STEELS

"Manufacture and Uses of Alloy Steels," is the title of Bulletin 100, just issued by the United States Bureau of Mines, Department of the Interior. Copies of this bulletin may be obtained by addressing the Director of the Bureau of Mines, Washington, D. C.

Alloy steels are bringing about a series of revolutions in various industrial fields in which steel plays an important part. Most elements that could be procured in sufficient quantity have been alloyed with iron in various proportions, either alone or in combination with others, in the search for useful alloy steels. Those steels that have gained and maintained for themselves a place in current use are discussed in this report.

Probably the first useful alloy steel was Mushet's self-hardening tungsten tool steel, patented in 1868. Fifteen years later chromium steel really containing chromium, was struggling for recognition for some purposes, the chief of which was for the manufacture of solid shot for piercing armor. In both of these steels the effect of the alloying element as used was in a way proportional to the amount contained. In 1882 Hadfield made his epoch-making discovery of manganese steel and demonstrated that in iron metallurgy it is not safe to take for granted anything as to the properties of an alloy of iron with other elements, basing one's opinion on past experience and knowledge, and that the effect of an alloying element may not be proportional to its content.

The bulletin treats of simple tungsten steels, simple chromium steels, mangenese steel, simple nickel steels, nickel-chromium steels, silicon steels, high-speed tool steels, and chromium-vanadium steels.

NEW PUBLICATIONS OF THE BUREAU OF MINES

Bulletin 86. Some engineering problems of the Panama Canal in their relation to geology and topography, by Donald F. MacDonald. 1915. 86 pp., 29 pls., 9 figs.

Bulletin 89. Economic methods of utilizing Western lignites, by E. J. Babcock. 1915. 74 pp., 5 pls., 5 figs.

Bulletin 114. The manufacture of gasoline and benzene-toluene from petroleum and other hydrocarbons. 1915. 268 pp., 9 pls., 45 figs.

Technical Paper 93. Graphic studies of ultimate analyses of coals, by Oliver C. Ralston, with a preface by Horace C. Porter. 1915. 41 pp., 3 pls., 6 figs.

Technical Paper 129. Metal-mine accidents in the United States during the calendar year 1914, compiled by Albert H. Fay. 1915. 96 pp., 3 figs.

Miners' Circular 20. How a miner can avoid some dangerous diseases, by A. J. Lanza and Joseph H. White. 1915. 24 pp., 4 figs.

VACUUM TRANSPORTATION OF DUST

A paper by T. C. Cloud in the Journal of the Society of Chemical Industry discusses the removal and conveyance of very fine material, such as, for example, flue dust from steam boilers, or impalpable powders produced in large quantities.

In a case with which the author had to deal, furnaces were producing a gas highly charged with arsenious oxide. This was to a large extent deposited in a complicated system of condensing chambers and flues, followed by filtration through bags in a bag house. The points at which it was necessary to remove the arsenious oxide from the bag house flues, etc., were numerous, and it was also necessary to deliver all the material to the packing room where it could be packed in casks for marketing. After some experimentation a vacuum plant, of which the following is a description, was designed:

The vacuum pump at normal speed of 160 r.p.m. has a displacement of 20,000 cu. ft. per hr. and will produce a vacuum of 18 in. of mercury if all valves to the various branch mains are closed. In the packing house the pipe main enters a cyclone separator in which the bulk of the arsenious oxide is deposited. Following this is another small separator. Finally the air is drawn through a shallow layer of water and then passes to the vacuum pump. The cyclone separator has a small storage capacity, and the arsenical soot is automatically removed from this apparatus and discharged into the casks placed below. The smaller separator is furnished with baffle plates and a collecting receptacle from which the deposit is only discharged at long intervals when the vacuum is off. The water separator is arranged so that a small continuous supply of water can be passed through it, or it may be charged and discharged intermittently.

In the piping about the works all bends and entering branches are of large radius, and for moving the material upwards all vertical members are avoided and inclined pipes substituted. At numerous points capped branches are arranged, to which, on the removal of the cap, suitable flexible hose, either metallic or reinforced rubber, can be attached. A suitable nozzle is fixed on the end of the hose, and on inserting this into the accumulated deposit the latter is immediately sucked up and conveyed to the separating plant.

This plant having an air pump capacity of 20,000 cu. ft. per hr. deals with 1½ to 2 tons of collected arsenious oxide per hr., and the farthest point at which a branch is situated is about 200 yd. from the separator. The pump in this instance is electrically driven, working at the rate of 12 to 14 h.p. It has been found that all annoyance caused by the handling of this material is removed and respirators are superfluous.

FOR INDUSTRIAL PREPAREDNESS

The following circular issued by the Naval Consulting Board accompanies letters sent out to the selected members of the engineering societies in each of the several States of the Union:

For the first time in the history of this country, engineers have been called as a body to its aid. Their service is needed by the Government in the performance of a most important patriotic work. They have been asked to aid in the laying of the foundations of our structure of national defence. Upon every one of them there rests a personal responsibility. The Country needs their service, the President has asked for it, and the governing bodies of the Engineering Societies have confidently pledged it. It is earnestly hoped that each and every one will find it possible to accept this nomination by his Society and to co-operate in this non-partisan, non-political and wholly patriotic work.

Brief outlines of Plan for Inventory of Industrial Resources Available for the Support of the Army and Navy of the United States.

1. Selection by each of the five great technical societies of one American Citizen from each State in the Union, as per President Wilson's request of January 13th.

2. The formal appointment by the Secretary of the Navy of the men so selected as State Directors of the Organization for Industrial Preparedness and Associate Members of the Naval Consulting Board.

3. Each State Board of Directors consisting of five men thus appointed to organize for business—electing Chairman and Secretary.

4. The organization under each State Board of a corps of Field Aides selected from the combined membership of the five technical societies within that State.

5. The issuance by the Naval Consulting Board to each State Board of complete information as to the work in hand, the objects to be obtained, suggested methods of procedure, lists of members within the State of the five technical societies and all available data as to the industries of the State.

6. Examination by the State Board of their territory with reference to the number and geographical distribution of industries with relation to the Field Aides available for the Inventory.

7. Issuance by the State Boards to the Field Aides of Instructions and Blank Forms as supplied by the Naval Consulting Board.

8. Examination and checking by the State Boards of all completed field reports. Following up men to see that reports are sent in properly. Checking reports and supplying

any data lacking before sending them to Consulting Board.

9. The continuance of the Organization thus formed in order to insure to the Government the backing of the full industrial strength of the country and to secure for the largest practicable number of industrial concerns such an amount of Government business as will keep them in touch with the requirements of the Army and Navy.

REHEATING DRIES THE AIR FOR THE SAND BLAST

On damp days we experienced trouble from the moisture in compressed air causing the sand to clog in the nozzles of our sand blasts, and at times from one-third to one-fourth of the operator's time would be occupied in endeavoring to clear away the obstruction. Several ways were suggested for drying the air, such as using a filter composed of pebbles and spongy material or passing the air through calcium chloride which is successfully used as a laboratory drying agent. The method which finally offered a solution of the problem consisted of placing gas burners beneath the main air pipe leading to the sand blasts, and since this plan was put into operation we have had absolutely no trouble from moist sand causing the apparatus to clog.—*George B. Morris in Machinery.*

NOTES

The cuts and description of the pneumatic blacksmith hammer in our February issue should have been credited to Railway Age Gazette by whose courtesy we were permitted to reproduce them.

Current is being transmitted from Sweden to Denmark through a submarine cable between Helsingborg, Sweden, and Elsinore, Denmark, a distance of about ten miles. The power comes from waterfalls in Southern Sweden.

A natural-gas pipe line, 800 miles long, is being constructed from the wonderfully rich natural-gas fields of southern Alberta to Winnipeg, Manitoba, at a cost of $10,000,000. When the line is completed it will supply 20 cities and towns along the way.

It is stated by those who should know that a cow from a given amount of feed will return more human sustenance than any other animal, and she apparently never hurries and never works hard.

A clever scheme, that appears to have originated in Scotland, is to gather pollen from the flowers with a vacuum cleaner for use as food for bees. The heather on wide stretches of moors provides ample supplies, and it is said that in some places the young bees have been mostly reared on this pollen.

Rock-drilling by contract, with payment made her foot of hole drilled, has not usually worked out satisfactorily. The miners place the holes where they are drilled most easily rather than where the smallest number of holes will break the greatest amount of ground. A price of 6 or 8 cents per foot of hole drilled was paid in hard limestone in Missouri.

Beginning Jan. 1, 1916, Denmark has introduced the twenty-four-hour system of computing time. In other words, 1 P. M. is to be termed 13 o'clock, and so on until midnight, which will be 24 o'clock. This system, which eliminates all doubt as to whether a given hour refers to day or night time, has already been introduced in various European countries.

Lake Titicaca, between Peru and Bolivia, is slightly over 13,000 feet above the level of the sea and is navigated by steamers of about a thousand tons, plying twice weekly between Puno in Peru and Guaqui in Bolivia.

It has been estimated that at least 85 per cent. of all rubber used in manufacturing goes to tires and only 15 per cent. to mechanical goods. The United States alone uses about 100,000 tons of crude rubber per year.

The mining of brown coal is one of the important industries of Germany. The coal varies in color from dark brown to almost black and is soft like loam. Pieces of wood and strips of bark and even parts of tree trunks are frequently encountered in the excavation, although the coal for the most part consists of a pulverulent, more or less matted mass of small particles of vegetal matter. It is a product between peat and lignitic coal.

The Engineer, London, gives a description of a method which has been adopted for storing oil fuel under water for the use of submarines. One of the submersible barges spoken of is in the form of a tank 150 ft. long and 30 ft. diameter, with hemispherical ends, which would carry 2,400 tons of liquid fuel, and could be submerged by admitting water to the compartments at the ends. To bring the vessel to the surface compressed air was introduced to force out about 30 tons of ballast water, or either oil or water could be pumped out through flexible tubes to make the vessel rise.

The price of blue-print paper and blueprints is likely to advance materially in the near future. This is due to the increase in the price of all chemicals employed in the blue process and also to the big advance in paper. Red prussiate of potash has been made exclusively in Germany. Before the war it sold for 19c per lb.; today it is practically unobtainable at $7 per lb., or an advance of 3,500 per cent. Citric acid, from which the citrates of iron and ammonium are made, has advanced 150 per cent.; and oxalic acid, from which the oxalates of iron are made, has advanced 1,000 per cent. in the same time.

It is estimated on fairly reliable although not official information that in England 27,000 men are engaged in building heavier-than-air flying machines. In addition, there are men engaged in building auxiliary equipment such as magnetos and carbureters. It is no exaggeration to say that in Great Britain alone about 40,000 men are now engaged in aeroplane work. It is stated in Germany by well-informed people that the English factories have an output of 140 machines a week. The French factories are doing their part; several plants in the United States and Canada are doing theirs. In Germany four big factories have been turned over to aeroplane building, among them one of the largest plants of the Allgemeine Elektrizitats Gesellschaft.

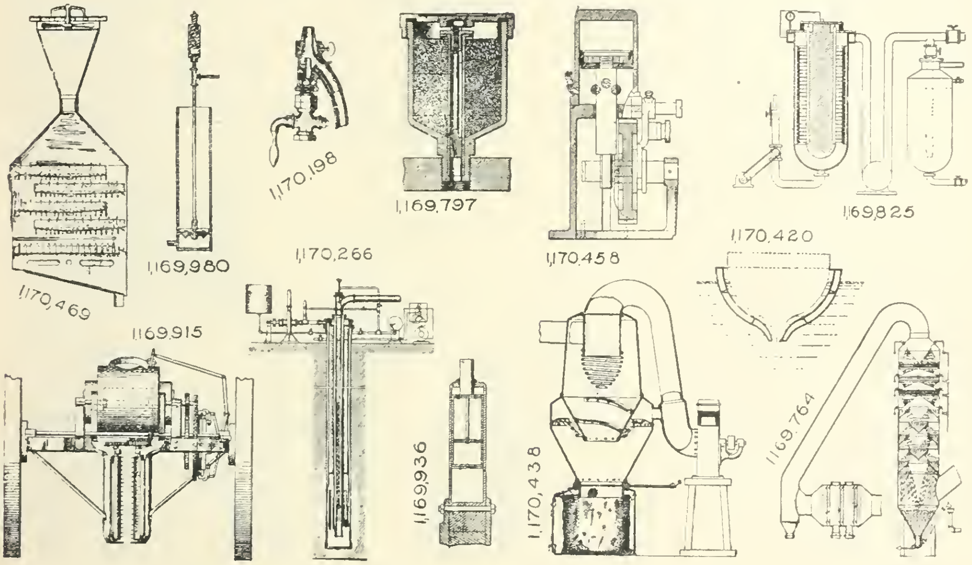
There was an apple orchard of four thousand trees to be planted, and as winter was approaching, no time could be lost, lest a sudden turn in temperature should freeze the ground. The man who undertook the work first mounted a 2½ horse-power gasoline engine on the running-gear of a light farm wagon, and arranged it to operate a soil-auger, and with this outfit two men were able to put down as many holes in a day as thirty men could have punched with a bar and sledge. In these holes light charges of dynamite were exploded to form excavations in which to plant the trees, a number of holes being fired at a time. By this method the entire orchard was planted in less than 15 days of 9 hours each.

In a lecture recently delivered before the Derby (England) Society of Engineers, Mr. H. M. Thornton said:—"It would hardly be too sweeping a statement to say that all the requirements of our Army and Navy are under tribute to gas in some way or other. Of my own personal knowledge, I know that the enormous output of war materials we have received from our manufacturers could not have been so rapidly made without the aid of industrial gas appliances, many of which, in their present economical and effective form, are of comparatively recent introduction. It is, I venture to claim, largely due to the service of industrial gas apparatus that our new armies were in a position to take the field much earlier than could otherwise have been the case."

Perhaps the most marked feature in the history of power production has been the replacing of reciprocating machinery by that of rotary type. The steam turbine has invaded and captured a considerable portion of the fields of usefulness of the reciprocating steam engine. The centrifugal water-pump has replaced the reciprocating pump; rotary condenser auxiliaries are rapidly superseding reciprocating plant, and rotary air blowers and compressors have entered into successful contest with reciprocating compressors. The principal factors which have decided the issue in favor of the rotary plant are: small space, excellent balance, and low first cost and maintenance. In the case of the steam turbine there is the important additional advantage of using steam which otherwise would be wasted.

Chains are designated by the diameter of the rod from which the links are made, as ½ in., 1 in., etc.; also by the form of the link, as close-link, in which one link is just large enough to inclose the two adjacent ones; open-link, in which the link is larger than in close-link; bar-chain, which consists of open links with a bar across the middle of each; twisted-link, in which each link is twisted through a certain angle, usually 90 degrees; and straight- or flat-link, which is not so twisted.

There is now recognized a special form of skin eruption due to the handling of cement. It is becoming prevalent since the extensive use of reinforced concrete. This eruption is commonly produced on the hands, fore-arm or breast when the workmen have these parts uncovered; also sometimes on the face, and the malady resembles the itch from the sensation which it produces. The effect comes from the alkaline contents of the material, and where the skin is already softened by contact with water, such substances have a marked effect. But such lesions of the skin are not serious, and a few days' rest with the use of a soothing liniment or a zinc ointment will cause the trouble to disappear. Covering the skin with a fatty substance and the use of suitable cloth gloves is a prevention, and it is recommended to give the exposed parts a good cleaning at the end of the day.



Pneumatic Patents February 1.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

FEBRUARY 1.

1,169,764-5-6. METHOD OF GAS-WASHING. Hermann A. Brassert, Chicago, Ill.

1,169,197. LUBRICATOR. Harry R. Geer, Johnstown, Pa.

1,169,825. METHOD AND APPARATUS FOR MAKING OZONE. William T. Hoofnagle, Glen Ridge, N. J.

1,169,896. VACUUM-CONTROLLING DEVICE FOR PLAYER-PIANOS. Edwin S. Werolin, Brooklyn, N. Y.

1,169,915. COTTON-PICKING DEVICE. Rudolph F. Beran, Moulton, Tex.

1,169,919. APPARATUS FOR DRYING GAS. Hermann A. Brassert, Chicago, Ill.

1,169,936. AIR-CUSHIONED WHEEL. Charles I. Dickerson, Duchesne, Utah.

1,169,980. EXHAUST-PUMP FOR MILKING-MACHINES. Kenneth K. McLeod, St. Paul, Minn.

1,169,995-6. METHOD OF PRODUCING ARTIFICIAL RESPIRATION. Roscoe S. Prindle, New York, N. Y.

1,170,198. SAND-BLAST DEVICE. John E. Sweet, Anthony Winter, and Frank G. Chambers, Syracuse, N. Y.

1,170,203. AIR-PUMP FOR VACUUM-CLEANERS. Theodore Wiedemann and Joseph H. Templin, Philadelphia, Pa.

1,170,266. APPARATUS FOR OPERATING SULFUR-WELLS. William Daniel Huff, La Fayette, La.

1. An apparatus for operating sulfur mines, comprising a well casing provided with perforations near its bottom, hydrocarbon burners contained in said casing near the bottom thereof for heating the water in the well, and causing the same to melt the sulfur, a central pipe to carry off the fused products projecting down in said casing between the burners, an air tube

mounted in said pipe and provided with an air jet at its lower end, and means for supplying air under pressure to said tube, substantially as described.

1,170,420. PNEUMATIC NON-SINKABLE SHIELD FOR BOATS. CHARLES CROWLEY, Perth, Australia.

1,170,436. VENTILATOR. CHRISTIAN ERICKSON, York, N. D.

1,170,438. APPARATUS FOR SEPARATING DUST AND FOREIGN MATTER FROM AIR. CALLO D. FAHRNEY, Milwaukee, Wis.

1,170,458. AIR-PUMP FOR AUTOMOBILES AND THE LIKE. VICTOR H. PETERSON, Cambridge, Mass.

1,170,469. APPARATUS FOR DRYING AND STERILIZING AIR. REINDER PIETERS VAN CALCAR, Oegstgeest, and JAN ELLERMAN and HENDRIKUS JOHANNES MARTIJN, The Hague, Netherlands.

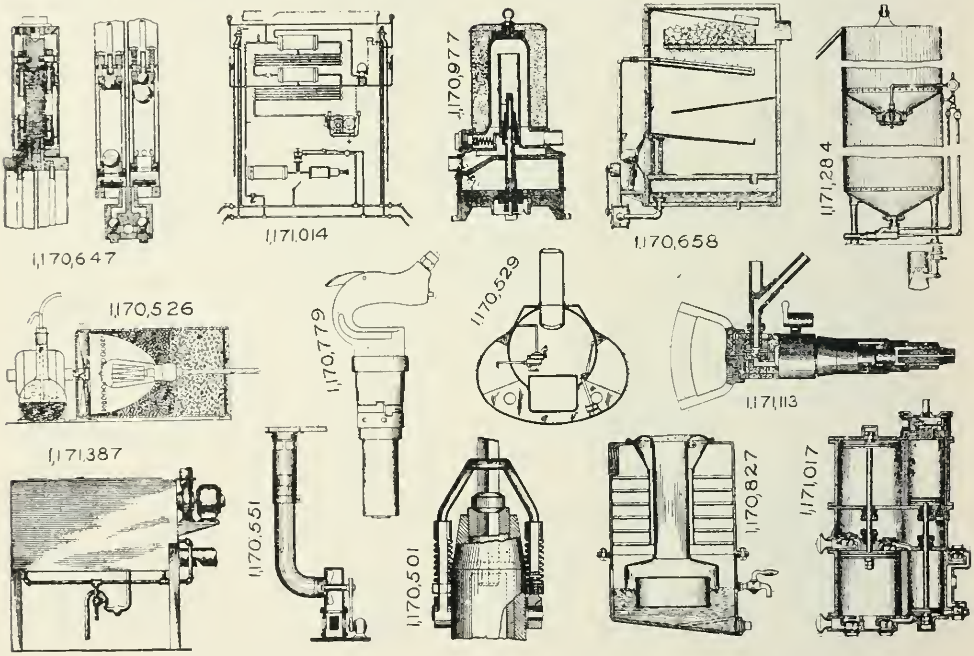
1. The combination in a pneumatic pump, a cylinder, an air outlet passage, a piston working within the cylinder and having an opening, a guide carried by the piston, a buoyant valve guided by said guide and seatable over the opening of the piston, a valve carried by the guide for closing the air outlet passage, and means for yieldingly moving the guide to seat the last mentioned valve.

1,170,658. AIR COOLING AND PURIFYING APPARATUS. JOSEPH B. MITCHELL, Detroit, Mich.

1,170,779. HANDLE-LOCKING DEVICE FOR PNEUMATIC TOOLS. REINHOLD A. NORLING, Aurora, Ill.

1,170,807. COMPRESSED - AIR - EXHAUST MUFFLER. EUGENE EGAN, Kingston, N. Y.

1,170,827. AIR-HUMIDIFIER FOR EXPLOSIVE-MOTORS. JOHN M. KROYER, Stockton, Cal.



PNEUMATIC PATENTS FEBRUARY 8.

FEBRUARY 8.

1,170,501. SPRING - MUZZLE FOR ROCK-DRILLING ENGINES. WILLIAM T. AYER, Dover, N. J.

1,170,526. APPARATUS FOR PURIFYING AIR. WALLACE H. GAITHER, Pittsburgh, Pa.

1,170,529. SUBMARINE BOAT. HUGO E. GRIESHABER, New London, Conn.

1. A submarine boat having a strong inner hull, a relatively weak outer hull, means for admitting water to the space between the hulls, means for admitting air to the space between the hulls to expel the water therefrom, and means for automatically regulating the pressure of the air admitted to the space between the hulls with reference to the pressure of the water surrounding the boat; substantially as described.

1,170,534. AIR-HOSE COUPLING FOR RAILWAY CARS. WILLIAM H. HIDLEBAUGH, Gould, Okla.

1,170,551. VENTILATING APPARATUS. JOHN M. MARTY, Cleveland, Ohio.

1,170,647. PUMP. JOHN L. LATTA, Hickory, N. C.

1,170,942. PNEUMATIC-CUSHION SUPPORT FOR AUTOMOBILE-BODIES. JOSEPH M. SULLIVAN, Dallas, Tex.

1,170,976. HEATER FOR MOTOR FLUIDS. OTTO A. KREUTZBERG, Lake Bluff, Ill.

1,171,014. SAFETY MEANS FOR PREVENTING AND REMOVING ICE AND OTHER OBSTRUCTIONS IN FLUID - PRESSURE SYSTEMS. EDWARD W. ANGER and HARRY H. HORNSBY, Chicago, Ill.

1. The herein described method of preventing or removing a formation of frost or ice in the pipes, tanks, valves and the like, of a system in which there is a flow of air, which consists in causing to be injected into the air an agent which forms with moisture or water a mixture tending to prevent the existence of ice or frost.

1,171,017. FLUID-COMPRESSOR. JOHN S. BARNER, Albany, N. Y.

1,171,113. PRESSURE - FLUID - ACTUATED TOOL. GEORGE H. GILMAN, Claremont, N. H.

1,171,286. SAND-BLAST MACHINE. HOWARD L. WADSWORTH, Cleveland, Ohio.

1,171,387. AIR - COOLING APPARATUS. GEORGE F. DICKSON, Chicago, Ill.

FEBRUARY 15.

1,171,599. TRIPLICATE VACUUM AND AIR TRAP. Ruel E. Dewey, Grand Rapids, Mich.

1,171,669. MACHINE FOR DRESSING CHICKENS. William Short, Denison, Iowa.

1. In an apparatus of the character described, an air conduit and a movable fowl carrier mounted upon the conduit and adapted to be operated to dispose a fowl carried thereby within the conduit and subject the same to a blast of air passing therethrough whereby the feathers are removed from the body of the fowl.

1,171,677. APPARATUS FOR BURNING GAS. Nelson Thomas and Anson W. Allen, Birmingham, Ala.

1. In a burner for open hearth furnaces, the combination of a pipe projecting inwardly from the rear wall of the burner, a second pipe surrounding said first pipe and providing a water space between said pipes, inlet and outlet water connections to said space, a gas connection to said inner pipe, a third small pipe located internally of said inner pipe and terminating short of the mouth thereof, means for maintaining said small pipe in axial alinement with the pipe in which it is held, means for supplying high pressure air to said small pipe and additional means for supplying air around the gas pipe, substantially as described.

1,171,695. VACUUM-AIR-LINE GOVERNOR. Joseph H. Brady, Kansas City, Mo.

1,171,788. COMPRESSOR. Leonard B. Harris, Haddon Heights, N. J.

1,171,926. MOTOR-DRIVEN GAS-COMPRESSOR. Henry A. Carpenter, Sewickley, Pa.

1,171,928. GLASS SEVERING AND PRESSING MECHANISM. George E. Cleveland, Fairmount, Ind.

1,171,986. WELL-PUMPING SYSTEM. William M. Stephenson, Dallas, Tex.

1. A well-pumping system comprising a substantially closed receptacle mounted in the bottom portion of a well and having a valve inlet, of a discharge pipe leading from said receptacle out of the well, air supplying and air exhausting means having connection with said receptacle, and a device alternately actuated by the hydrostatic pressure of a fluid entering the receptacle during the period of its connection with the air exhausting means, and by gravity, automatically cutting off communication of the receptacle with the exhausting means, and establishing its communication with the supplying means when the receptacle is substantially full of the fluid, and automatically producing the reverse result when the receptacle is substantially empty.

1,172,001. PNEUMATIC BUMPER. Edward A. Baker, Samuel W. Johnston, and Leslie H. Johnston, Mansfield, Ohio.

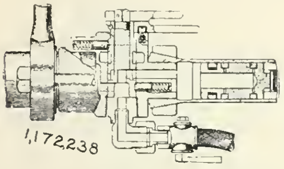
1,172,008. CONTROLLING DEVICE FOR SAND-BLAST APPARATUS. Frederick A. Coleman, Gates Mills, and David S. Hawkins and Albert J. Farrell, Cleveland, Ohio.

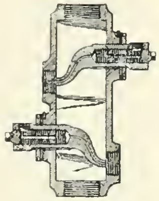
1,172,036. AUTOMATIC AIR-COUPLING. John H. Nicolson, Birmingham, Ala.

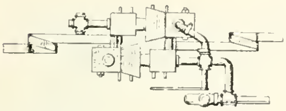
1,172,206 AIR-HAMMER. Alonzo Griggs, Charleston, S. C.

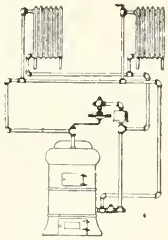
1,172,212. SANDER. Christian A. Johnson and Hans Thissenius, Laramie, Wyo.

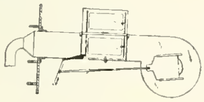
1,172,238. PRESSURE-FED TOOL. George H. Gilman and William C. Michael, Claremont, N. H.

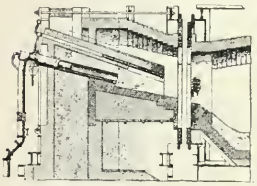

1,172,238

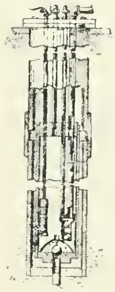

1,172,212

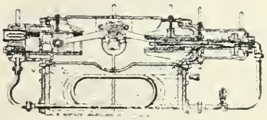

1,172,036

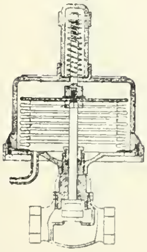

1,171,599

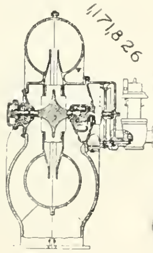

1,171,669

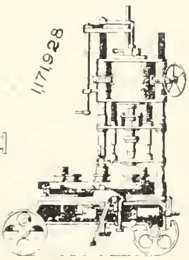

1,171,677


1,171,986


1,171,788


1,171,695


1,171,826


1,171,928

Pneumatic Patents February 15.

FEBRUARY 22.

1,172,247-8. VACUUM-BOTTLE. Charles F. P. Anders, Hoboken, N. J.

1,172,250. PNEUMATIC ACTION. Harry Bainton, New York, N. Y.

1,172,279. APPARATUS FOR APPLYING AIR-BLAST TO INGOTS. Robert Abbott Hadfield, Westminster, England.

1,172,288. FLUID-OPERABLE MECHANISM. Reynold Janney, New York, N. Y., and Harvey D. Williams, Wallingford, Conn.

1,172,429. METHOD FOR DEHUMIDIFYING AND COOLING AIR. Willis H. Carrier, Buffalo, N. Y.

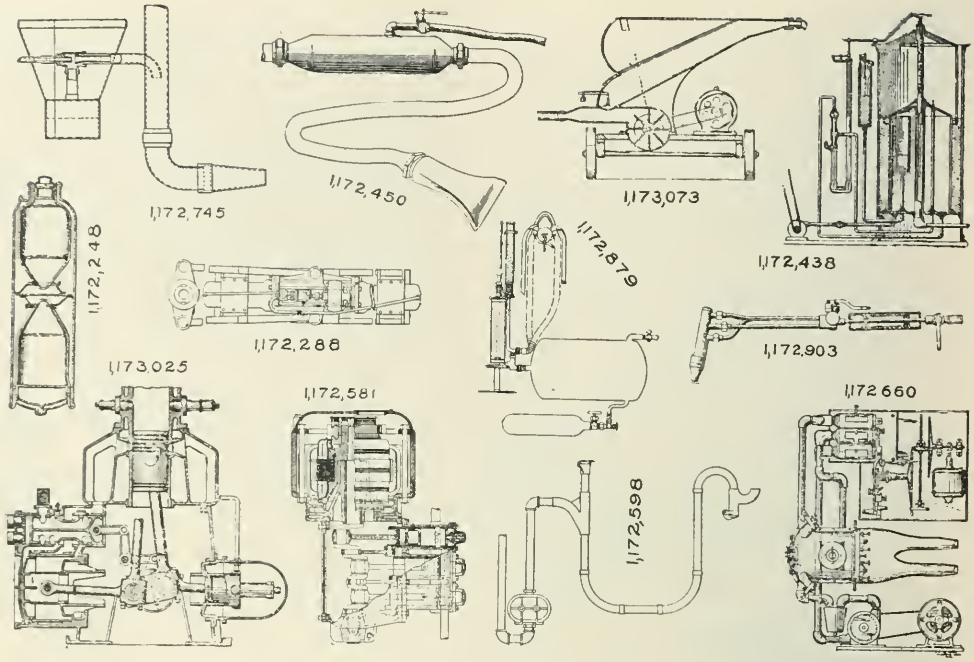
1,172,438. AUTOMATIC AIR CONTROLLING DEVICE. Frank E. Crotto, Dallas, Tex.

1,172,450. PNEUMATIC CLEANER. William T. Griffin, Washington, D. C.

1,172,535. GAS COMPRESSING OR CIRCULATING SYSTEM AND APPARATUS FOR USE THEREIN. Alexander E. Keith, Hinsdale, Ill.

1,172,575. DEHYDRATING APPARATUS. William A. Wood, Dunellen, N. J.

1,172,581. MOTOR-DRIVEN COMPRESSOR. Herbert W. Cheney, Milwaukee, Wis.



Pneumatic Patents February 22.

1,172,598. PNEUMATIC - DESPATCH - TUBE APPARATUS. John S. Jacques, Hingham, Mass.

1,172,660-1-2. SYSTEM FOR THE TREATMENT OF DISEASES OF THE HUMAN BODY BY VACUUM OR AIR-PRESSURE. Charles E. H. Armbruster, Denver, Colo.

1,172,716. PNEUMATIC DIAPHRAGM. Joseph Knagge, Chicago Heights, Ill.

1,172,745. APPARATUS FOR FEEDING PULVERIZED FUEL. George W. Short, Sharon, Pa.

1,172,879. APPARATUS FOR ADMINISTERING OXYGEN TO PERSONS IN A STATE OF COLLAPSE BY ASPHYXIATION OR OTHER CAUSES. Robert Henry Davis, London, England.

1,172,901. FLUID-OPERATED DRILL. Caid H. Peck, Athens, Pa.

1,172,903. CUTTING-TORCH OR BLOWPIPE. Marion Stuart Plumley, Pittsburgh, Pa.

1,173,025. INTERNAL - COMBUSTION ENGINE AND COMPRESSOR THEREFOR. Otto F. Persson, Erie, Pa.

1,173,073. PNEUMATIC CONVEYER. Benjamin L. Williams, Corning, Mo.

FEBRUARY 29.

1,173,156. PNEUMATIC WHEEL. Frank W. Addington, Richmond, Ind.

1,173,178. SAND-BLAST MACHINE. John L. Dawes, Pittsburgh, Pa.

1,173,247. PNEUMATIC HAMMER OR LIKE PERCUSSION-TOOL. Harry Samuel Bickerton Brindley, Westminster, London, England.

1,173,250. SACK-CLEANING DEVICE. Adolph G. Carlson, Chicago, Ill.

1,173,252. SECURING MEANS FOR STRIKER-PNEUMATICS. Melville Clark, Chicago, Ill.

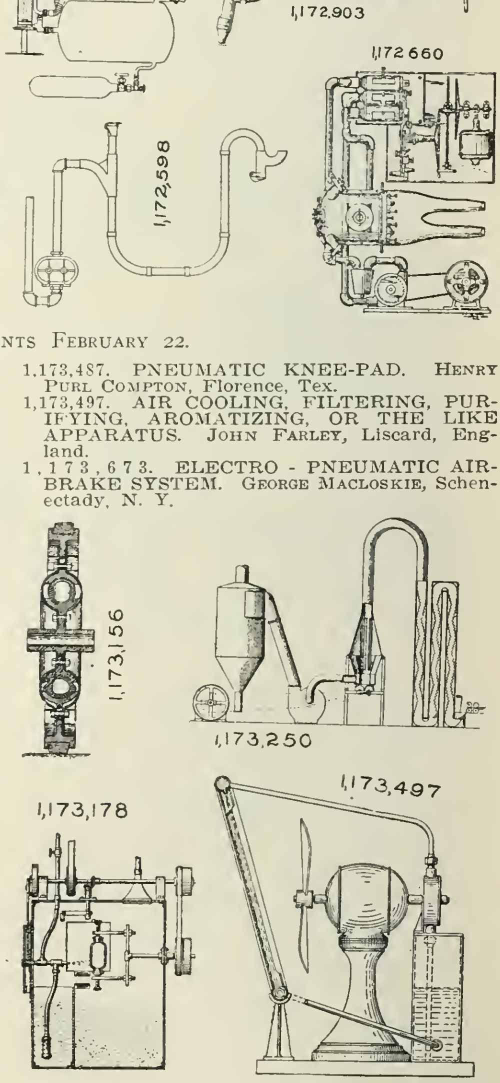
1,173,326. AIR-OPERATED TOOL. George T. Taylor and John Leslie Taylor, Sterling, Ill.

1,173,404. AIR-CHEST. John T. Austin and Basil G. Austin, Hartford, Conn.

1,173,487. PNEUMATIC KNEE-PAD. Henry Purl Compton, Florence, Tex.

1,173,497. AIR COOLING, FILTERING, PURIFYING, AROMATIZING, OR THE LIKE APPARATUS. John Farley, Liscard, England.

1,173,673. ELECTRO - PNEUMATIC AIR-BRAKE SYSTEM. George Macloskie, Schenectady, N. Y.



Pneumatic Patents February 29.

COMPRESSED AIR MAGAZINE

7991

EVERYTHING PNEUMATIC.

Vol. XXI MAY, 1916 No. 5

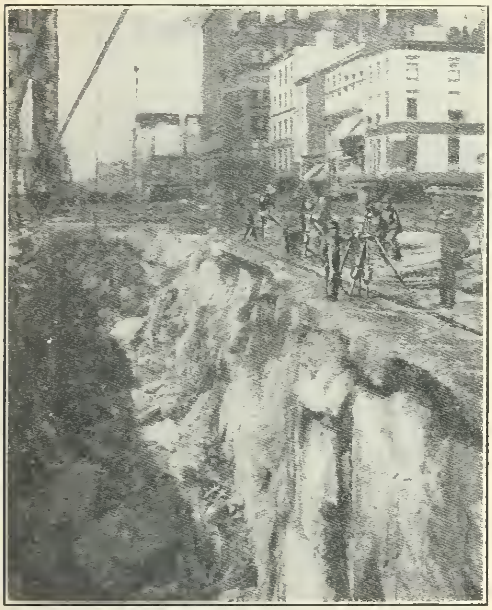


FIG. 1.

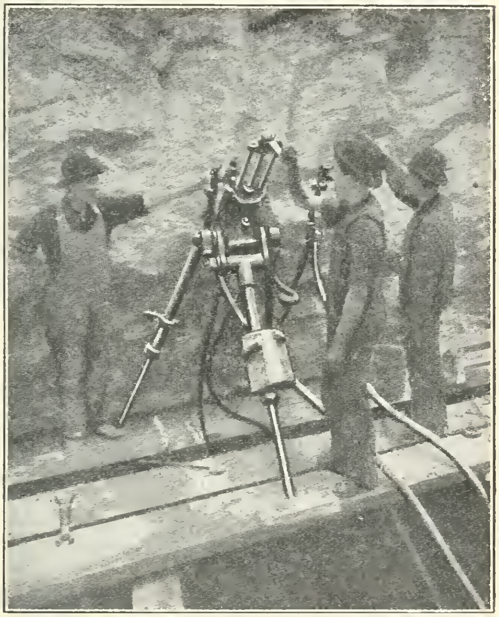


FIG. 2.

SUBWAY EXCAVATING REVOLUTIONIZED

BY CHAS. A. HIRSCHBERG.

It is not a far cry in time, from the completion of the existing Broadway and Fourth avenue subways of Manhattan, New York, to the commencement of work on the new subway extensions, on Seventh avenue, Lexington avenue, etc., of the present day. To be exact, but slightly over 10 years have elapsed.

In this short space of time many changes have taken place, not so much in the general design of the subway itself, but in the means and methods employed for doing the work.

The island of Manhattan is a rocky ridge of gneiss and mica schist formation, with heavy seams of coarse-grained dolomitic marble and thinner layers of serpentine running through it, requiring the employment of rock drilling machinery and explosives for its removal.

In part the work consists of open cuts, calling for the drilling of down holes not unlike the methods employed in crushed rock quarry

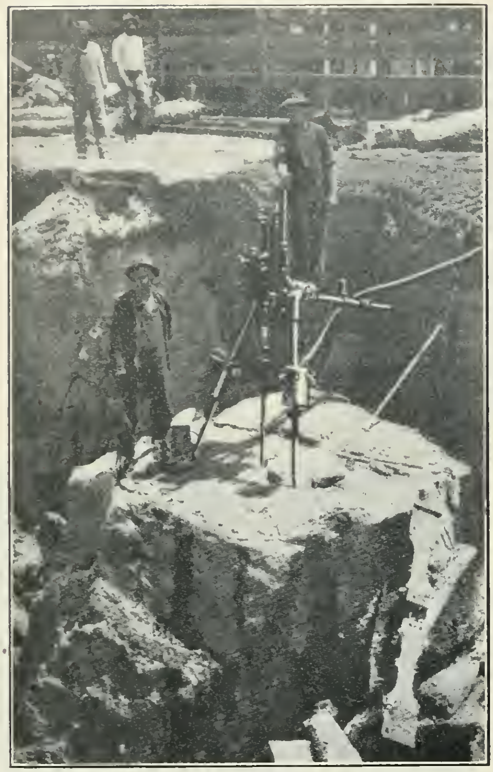


FIG. 3.

excavation, with the break confined, however, to predetermined restricted dimensions. Through congested traffic quarters, the work is prosecuted by using heading tunneling methods and where the capping is light the excavation kept covered to permit traffic to progress overhead.

The surprising dissimilarity between the past and present subway work is mainly found in the employment of rock drilling machinery, of such a radically different character, and possessing such obvious advantages over former equipment, that we are led to wonder at the accomplishments of the past.

It is to be remembered that the rock drills here to be spoken of, both the ancient and the modern, if we may so characterize them, are all driven by compressed air.

Fig. 1 depicts an open excavation proceeding on the old Fourth avenue subway, between Sixteenth and Seventeenth streets, with tripod drills weighing complete in the neighborhood of 500 to 600 lbs., and requiring from 2 to 3 men for their operation. In fact, the illustration clearly shows that three men comprised each drill crew.

Attention is called to the row of drilled holes, indicated by the wooden plugs. These holes, as will be noted, were put down at intervals of about 2 ft. and regularly spaced as to alignment. In spite of this, the break is decidedly irregular, as can be seen by examining the excavated portion. As a result trimming on side walls became necessary and this cost money and consumed time, especially as the trimming had to be done with the same type of heavy drilling machine, rigged up as best it could be done on scaffolding and other structures as will be noted in Fig. 2.

This was not the only extra expense to which the contractor was put by his drilling equipment. The rock often broke too large for handling and redrilling became necessary,

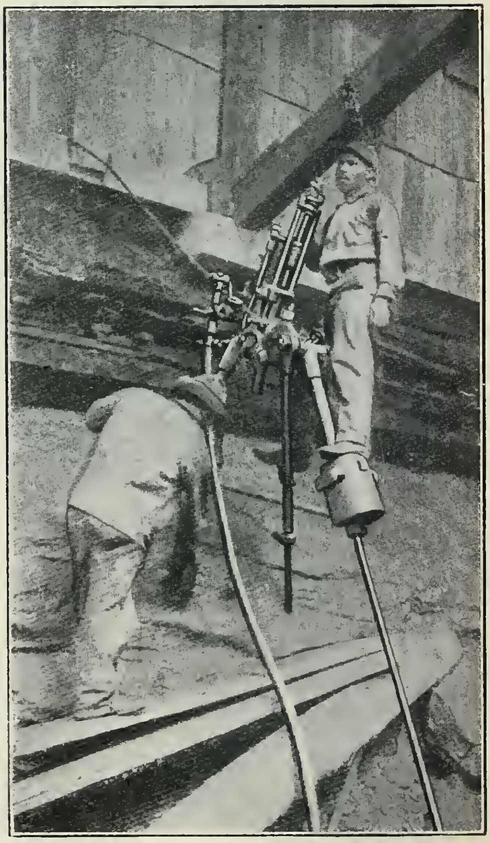


FIG. 4.

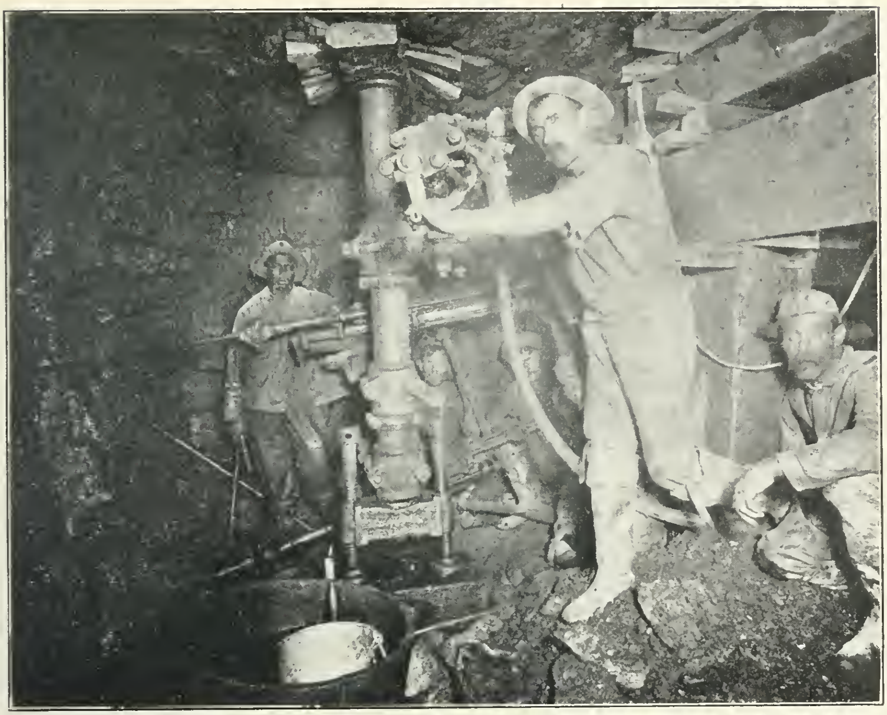


FIG. 5.

as shown in Fig. 3, and each time a drill was moved and set up, the derrick had to be employed and from 30 to 60 minutes lost rigging up.

The question naturally arises: Why weren't the holes drilled more closely together in the initial work to obtain better breaking effect? With the heavy tripod drill universally in use at that time, it was found to cost less to do the subsequent work of trimming and breaking than move the equipment frequently enough for close drilling. The holes were of fairly large diameter, generally starting at 2¾ to 2½ ins. and bottomed 1½ to 1¾ ins., using 2-ft. changes of steel. The holes were also drilled deep to avoid the cost of resetting the drilling equipment had shallow holes prevailed. Holes of the diameter named required time for their drilling, and necessitated using heavy steels and it cost time to change steels, loosening and tightening chuck bolts. These heavy steels had to be hand-sharpened, a slow process, and an uncertain one, owing to the class of labor available. The bits did not always follow, due to the irregularity of the hand-made bit and gauge. The method of drilling

FIG. 6.

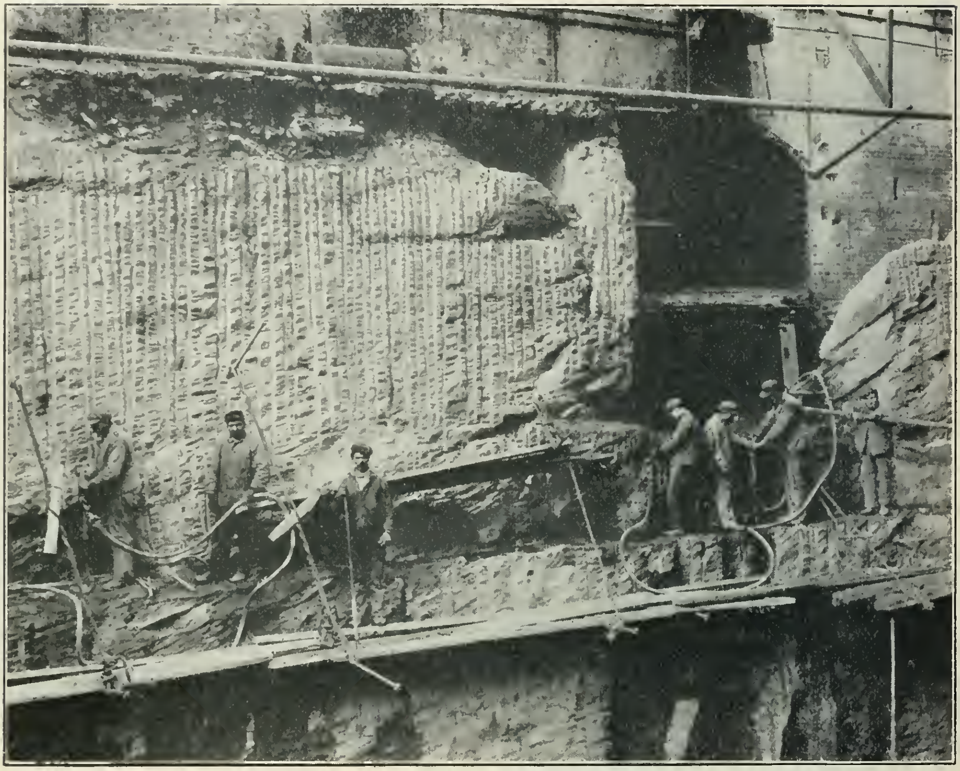


FIG. 7.

followed was found on the whole to be the least of several evils.

Fig. 4 shows a tripod drill at work in the shaft which was sunk at Forty-first street and Park avenue. The cumbersomeness of the equipment is at once apparent—it led to uncertain breaking, the use of scaffolding and a labor expense multiplied by 2 and often by 3.

Fig. 5 shows a breast in one of the tunnels. Large tools require large mountings, limit the placing of holes and the result is costly subsequent work.

A progress of 80 to 100 ft. of drill hole per day, in open excavation work, per tripod drill, employing 2 to 3 men, was considered good, and it was good at that time.

Likewise in tunnel work, where several holes could be drilled from an initial set-up, a drill hole footage of 90 to 120 ft. generally prevailed, while in shaft work the rate of drilling was somewhat lower than that with open cut work, owing to the necessity for more careful placing of holes and the interference of the spoil from previous blasts.

Let us examine the methods and equipment of today.

FIG. 8.

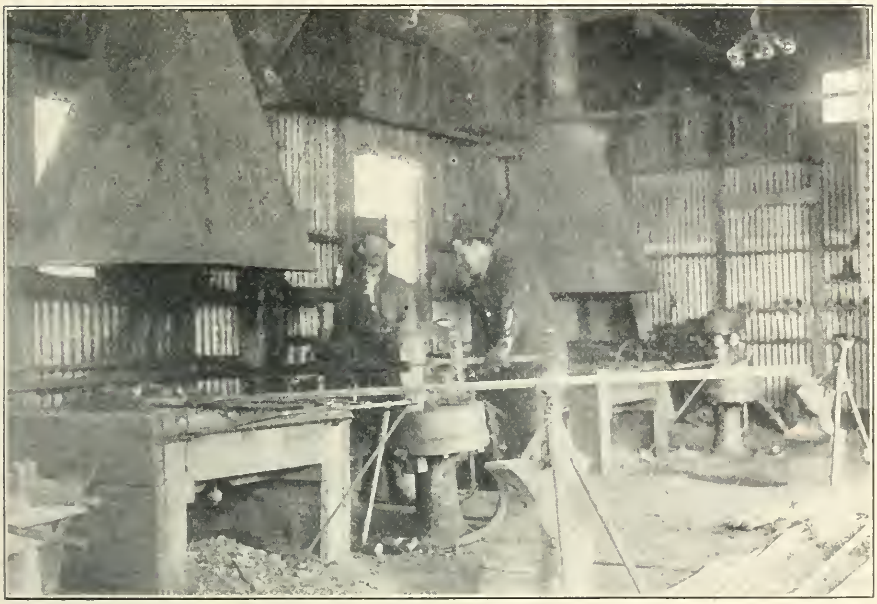


FIG. 9.

In Fig. 6 is shown an open cut excavation on the Seventh avenue subway at the Battery. Small 40-lb. hand-held, and practically self-operating drills, have replaced the heavy drills and their tripods. But one man, is employed in place of two or three, and he is having a comparatively easy time; in fact, he might almost be accused of loafing. There is no crank to turn, the machine rotates the steel for him. There are no chuck bolts to bother with—the steel rests loosely in the machine. Its light weight permits of quick shifting, and its small size enables it to work in restricted places, where you could not set a tripod without special rigging.

As a result holes are spaced closely together and the break is clean. While it is true that occasionally there is trimming to be done, it is accomplished so much more quickly, easily and cheaply that it scarely enters into consideration.

Fig. 7 shows a section of side wall. The spacing of the drill holes and the cleanliness of the break are clearly indicated.

The average drilling progress is in the neighborhood of 120 to 150 ft. per drill, per day, accomplished with but one man and in the place of a few machines, as in the case of the tripod drill, the job swarms with them, expediting greatly all operations.

The size of hole drilled generally bottoms 1¼ ins. employing starters of 1¾ ins.

Fig. 8 shows a shaft sinking view. Here again is a demonstration of clean breaking, a direct result of the type of drilling machine. Holes can be placed where the best breaking effect will result. A greater number of drills can be operated and the shaft sunk in much less time. Drilling and mucking proceed simultaneously, and there is no delay. Stops are only made to permit blasting, when the equipment is removed and returned with a minimum loss of time.

One contractor who has had experience in shaft sinking with both classes of drills gives the following basis of comparison:

Size of shaft	15x16 ft.
No. of drills used	2 Jackhamers.
Character of ground	Hard.
No. of shifts per day	3 8-hr.
Total time	4 months.
Total depth sunk	359 ft.
Average progress per month	89.75 ft.

Best previous record made in shaft sinking with tripod drills by this contractor, under very similar working conditions was 61 ft. per month.

On working where tunneling methods are necessary a decided increase in progress is also to be noted. A drill hole footage of 120 to 150 ft. per day is not uncommon.

With the advent of these light rock drilling machines came the drill steel machine sharpener shown at work in Fig. 9. In this particular installation the operator turns out an average of 60 cross bits per hour from the blank on 1-in. hollow hexagon steel. The resharpening of drill steel is considerably faster.

The bit is of a superior character to the hand-sharpened bit, being true to gauge and practically perfect in form. The result is added drilling speed to an already rapid drilling equipment.—*Min. and Eng. World.*

STUDY OF MACHINE DRILLING AT TREADWELL MINES, ALASKA

BY E. P. KENNEDY

For years the standard machine drill in use in the Treadwell mines (the Treadwell, Mexican, 700 and the Ready Bullion mines, all of which are connected by underground workings and are under the one management) was the Ingersoll-Sergeant piston machine. Two sizes were in use—the 3¼ and the 3⅝-in. machines. Shaft sinking was done exclusively with the larger machines, which were also used in the open pits.

In the openpits, holes were drilled 12 ft. deep, approximately vertical, with a set of steel consisting of six drills. No openpit work was done after the year 1907. Holes underground were drilled approximately 7 ft. deep and a standard set of steel prior to 1908 for underground use in the Treadwell mines is described in the following tabulation:

	—Shank End—		—Bit End—		—Drill—		
	Length,	Size Oct.	Length,	Size Cru.	Length,		Gage,
No.	In.	In.	In.	In.	Ft.	In.	In.
1	18	1¼	18	1¾	3	..	2¾
2	44	1¼	14	1¾	4	10	2½
3	66	1¼	14	1¾	6	8	2¼
4	88	1⅛	14	1½	8	6	2

The set of steel weighs approximately 110 lb. and was made up by contract at a cost of 35c a drill for labor only, to which should be added the cost of coal or oil, borax and steel wasted in welding. The chucks of the machines to receive the drills were fitted with octagon bushings to receive the 1¼-in. octagon drill shank, and the 1⅛-in. shank of the No. 4 drill was upset to 1¼-in. size.

In January, 1908, I had a machine fitted up with a cruciform bushing to receive 1½-in. cruciform steel and had sets of steel made up as follows:

	Length,		Dia. Cru.,	Gage,
No.	Ft.	In.	In.	In.
1	3	..	1½	2¼
2	4	10	1½	2
3	6	8	1⅜	1¾
4	8	6	1¼	1½

An extended trial with this machine proved conclusively the advantage of changing, and as rapidly as it could be economically done, all piston machines were fitted with cruciform bushings and the old steel gradually replaced by the new drills. The change of gage reduced the amount of material to be cut in drilling a hole by 37 per cent., and the change to all cruciform steel obviated welding and also reduced the weight of steel per set 14 per cent.

The main difficulty to be overcome before making the change was to obtain satisfactory cruciform chuck bushings at a reasonable cost. This was accomplished by purchasing cast-steel bushings which only required to be finished on the outside after receiving at the mine. These bushings cost 35c each in the East and proved in every way satisfactory.

TRYOUT OF HAMMER-STOPING MACHINES.

Early in 1908 the writer made a thorough tryout of the hammer-stoping machines then on the market. A stope was turned over exclusively to these machines in charge on each shift of a reliable, unbiased, first-class miner, exceptionally well qualified, as known through long personal acquaintance, to give a thorough and fair trial. A three months' trial proved conclusively that this type of machine was not adapted for stoping as carried on at Treadwell. These machines are best adapted for more or less vertical holes, and a number of them are always in use in the mines for drilling survey and light plugs and in driving raises where the ground is not too hard. Slate raises are always driven with hammer drills, but when a very hard rib of ground is encountered, the contractors set up a bar and haul up a 3¼-in. piston machine—a hard task when the raise is of any height, though a profitable one as they have found by experience.

Water-Leyner machines were then tried, and they survived the prejudice against introducing anything new and proved their economy over the piston machines.

EFFECT OF INTRODUCING WATER-LEYNER DRILLS

These water-Leyners were strictly one-man machines weighing about 110 lb., and they averaged as much footage per shift in the stopes as the two-man piston drill. The increased cost for hollow steel, drill-sharpening, oil, general repairs and upkeep was far more than offset by the saving in labor. The rate of air consumption for the water-Leyner was about 80 per cent. of the 3¼-in. piston machine, but as the Leyner ran steadier, the daily air consumption might not be much different. By 1913 all stoping piston machines in the Mexican, 700 and Ready Bullion mines had been gradually replaced by water-Leyners, and progress was being made toward replacing the piston machines in the Treadwell mine.

A Treadwell mine crew drove the main crosscut 12 ft. wide, from the central shaft on the 2,100-ft. level by using a crossbar on which were mounted four water-Leyner machines, making a progress in the month of April, 1914, of 372 ft., which was far more than was ever made in any of the mines previously in the same length of time. The crosscut was started with two piston machines run by a machine man and helper. Overnight this equipment was replaced by four Leyner machines, and the machine helpers became, like their partners, machine men. These water-Leyner machines finally overcame the misgivings of the dyed-in-the wool piston-machine men and made a good start toward replacing piston machines in the Treadwell mine.

Shaft sinking had been done with 3⅝-in. piston machines for so long that when it was decided to sink the Ready Bullion shaft with hammer drills, the contractors would not bid on the shaft. It was therefore sunk on a day's-pay basis at a saving to the company, and proved a demonstration to the contractors, who were willing to take the shaft on contract before sinking had finished. Since the sinking of this shaft, the self-rotating jackhamer machines have been introduced and proved a great improvement.

OLD PRACTICE OF DRILLING LONG ROUNDS DEPRECATED.

The popular slogan adopted generally by up-to-date enterprises of the day—"Safety First"—calls loudly for the change of the old practice of drilling long rounds in the bottom of a shaft. Such necessitate the use of large quantities of powder, produce a great pile of muck, expose the crew to the danger of exploding powder in cleaning it out and later to the danger of drilling into missed holes. The change to the jackhamer machine will answer this call, and the same slogan will hurry along the replacement of piston machines in drifting by the water-Leyner type.

Following is a tabulation of the average footage drilled per machine-shift for a period of seven years by machines engaged in stoping:

Year	Ready Bullion	Mexican	Treadwell
1907	33.3 ft.	31.1 ft.	....
1908	31.7 ft.	25.9 ft.	33.0 ft.
1909	33.1 ft.	27.2 ft.	26.1 ft.
1910	29.4 ft.	33.5 ft.	26.6 ft.
1911	32.7 ft.	28.6 ft.	27.9 ft.
1912	34.5 ft.	31.0 ft.	26.4 ft.
1913	34.0 ft.	29.4 ft.	28.3 ft.

The Treadwell fiscal year prior to 1911 ended in May. Tabulation for 1911 under Treadwell mine includes 18 months, making the Treadwell mine year conform to the Ready Bullion, Mexican and calendar year thereafter.

The figures under Treadwell mine represent the drilling of 3¼-in. piston machines, the figures for the first four years under Ready Bullion Mine and Mexican Mine represent the drilling of 3¼-in. piston machines, the next two years include piston and water-Leyner machines, while the figures for the year 1913 represent the drilling of water-Leyner machines exclusively.

Although the benefit derived from the change of gage for the piston machines is not reflected in the figures given, it was owing to this change that a falling off did not follow in the drilling as a result of the disturbed condition following labor strikes in 1907 and 1908. The real aim in stoping is not drilling, but tons broken per machine shift. However as the water-Leyner machine in the stope is capable of drilling any hole with equal facility that the piston machine can, and it can moreover drill flat holes which cannot be drilled practically with the piston machine, it follows that the tonnage broken per Leyner machine shift can at least be made equal to the tonnage broken per piston machine shift, and probably will average to exceed it—*Eng. and Min. Journal.*

COMPRESSED AIR PULLS BY PUSHING

Some unusually interesting and ingenious engineering work occurred in the preparation of the sub-foundation of the Lincoln Memorial in Washington, one detail of which warranted the paradoxical title above. This sub-foundation consists of 122 reinforced concrete circular piers from 3 ft. 6 in. to 4 ft. 2 in. in diameter. The shells of these piers were steel cylinders each in three lengths sunk through sand and below that clay and then to a depth of 2 ft. in the solid rock, which was 34 ft. below mean low water level. It was expected that these shells would be operated in the usual way as caissons, the interior excavation being done under pressure, as is so familiar in downtown New York when a skyscraper is to be erected.

It was found, however, that the clay was so watertight that, with some pumping of the inflow, the interior excavation could be done without the air pressure. The excavation of the rock for the final footing of the piers was of course done with pneumatic drills as usual. As the cylinders descended they were subjected to considerable external pressure from the clay which closed around them, so that heavy weights were required to force them down.

It happened that in sinking the cylinders several piles were encountered. Most of these piles came within the cylinders and could be dug out, but one caught the edge of a cylinder and deflected it 3½ ft. from the vertical so that it was necssary to draw it out and start it again. To do this pulling there was not only the entire weight to be lifted but also the pinch of the surrounding clay to be overcome.

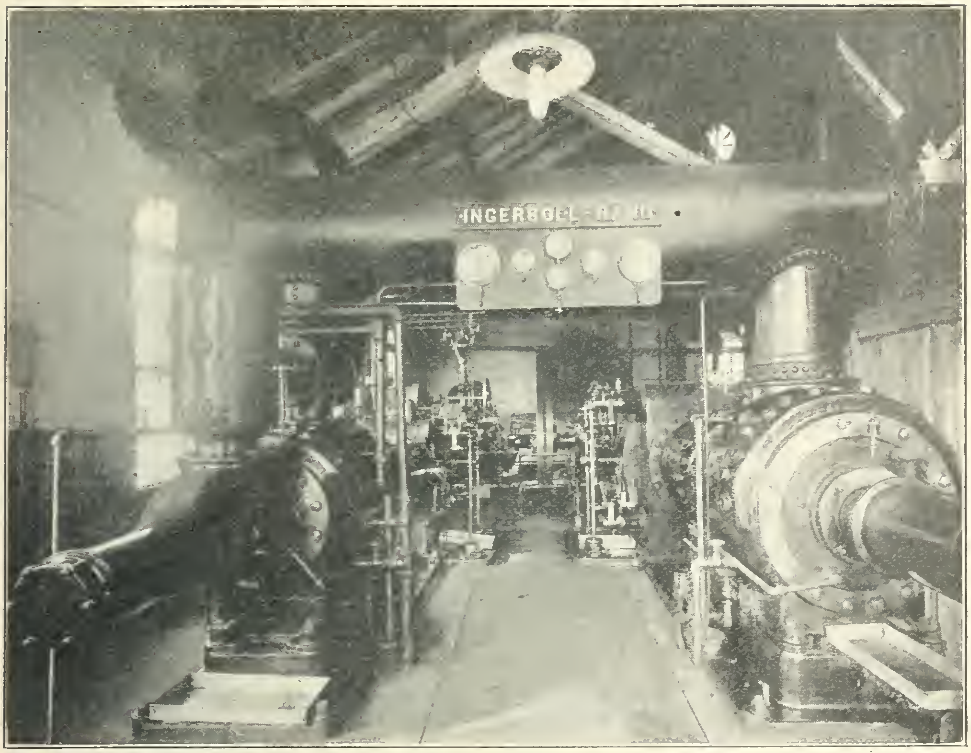
The cylinder was closed with an air tight top bolted to angle irons and a lifting pressure of about 50 tons was applied by derrick and jacks, but this failed to move the cylinder. It was then allowed to fill with water from the bottom and compressed air at a pressure of nearly 100 lb. was admitted to the top of the cylinder. If this air had been admitted slowly its effect would have been chiefly to expel the water, but as it was turned on as suddenly as possible the pressure under the cylinder head, aggregating more than 80 tons, and resisted below it by the inertia of the body of water was effective help for the lifting of the cylinder. The air pressure was thus turned on suddenly twelve successive times, and the cylinder was only raised about an inch. On the next trial, however, the cylinder shot up 15 ft. and was then easily removed and subsequently sunk again in correct vertical position.

GASOLINE LOCOMOTIVES BAD FOR MINE AIR

"Gasoline Mine Locomotives in Relation to Safety and Health," is the title of Bulletin No. 74, U. S. Bureau of Mines, and is authority for the following:

The noxious gases from a gasoline engine used in a mine must be so diluted by the air current as to make them harmless. Air with 0.05 per cent. carbon monoxide is sufficient to produce in time very slight symptoms of poisoning in man; 0.10 per cent. may cause a headache in 40 or 50 min. These facts seem to indicate that the allowable percentage of carbon monoxide should never exceed 0.1 per cent. for short and infrequent intervals, and that the average content should be kept below 0.05 per cent.

To keep the carbon-monoxide content of mine air below 0.10 per cent. would require that 1,000 cu. ft. of fresh air per min. pass the locomotive for each cubic foot of carbon monoxide possible for the locomotive to generate. The greatest proportion of carbon monoxide observed in the exhaust gases during the tests was 13.5 per cent. with the engine running at full speed and full load. The air required can be reduced in the ratio of twice the percentage of carbon monoxide actually found by test, to the maximum percentage of 13.5. Multiplying by 2 the actual percentage found by test provides a factor of safety to cover occasional lapses of operation and interruptions of ventilation. Thus a locomotive having four 7x7-in. cylinders is capable of generating with poor carburation 18 cu. ft. of carbon monoxide per min., and 18,000 cu. ft. of air per min. should pass the locomotive when so operated, to keep the proportion of that gas below 0.1 per cent. If the quantity of carbon monoxide produced during actual operation was shown by test not to exceed 4 per cent., it would seem safe and reasonable to assume that $\frac{8}{13.5} \times 18{,}000$, or 59 per cent of 18,000, or 10,700 cu. ft., would be a safe quantity under the stated conditions.



A MONEY SAVER OF THE KINGSTON COAL COMPANY.

HIGH CLASS EQUIPMENT PAYS WELL EVEN WITH COAL AT 40 CENTS PER TON

BY S. W. SYMONS.

Many coal operators seem to consider that a low fuel cost is sufficient warrant for installing low first-cost mechanical equipment, regardless of the operating economy to be expected.

This is particularly to be noted in the case of the much-abused air compressor. Reliability has been and still is considered a factor of prime importance, and the "old reliable" straight-line simple-engine-driven compressor has been almost invariably chosen.

Of late years, however, operators have come to realize more and more that the high-class duplex compressor, with compound steam cylinder and corliss-valve gear, and two-stage air ends, will give equally if not more reliable service, together with a decree of economy so far ahead of the straight-line machine as to warrant its installation when fuel is even as low as 40c a ton.

An instance of particular interest is that of the Kingston Coal Co., at Kingston, Penn., which some time ago discarded two straight-line-tandem-compound compressors (which had been in use only four years) and replaced them with a single duplex corliss machine with compound steam cylinders and two-stage air cylinders.

This installation is of interest to the coal operator since it shows in round numbers the saving made possible by the installation of refined, up-to-date equipment.

HOW IT HAPPENED.

Some years ago a consulting engineer—a salesman representing the Ingersoll-Rand Co.—stopped at the No. 4 breaker of the Kingston Coal Co., where there were two tandem-compound Meyer valve compressors, each having a rated capacity of 2,600 cu. ft. of free air per minute. The master mechanic made the statement that they were constantly installing boilers at this particular place, as their compressors were extravagant users of steam. The salesman suggested that instead of buying boilers they should buy an economical air compressor and save the expense of extra boilers and the continuous handling of coal. To drive the argument home indicator cards were taken from the compressors and a statement was made of the saving that could be expected

THE COMPRESSORS HAD BEEN INSTALLED RECENTLY.

The master mechanic stated that the compressors had been installed only a little over three years and it would not be possible to get his company to throw them out and purchase new ones. For 16 months the salesman continued to pound the Kingston company in an endeavor to secure the installation of a single corliss unit in place of the two straight-line machines, using operating economy as the "big stick," until finally an order was placed for a 30-in.-stroke corliss compressor having compound steam cylinders of 20 and 38 in. diameter and two-stage air cylinders of 20¼ and 33¼ in. diameter. The machine when operating at 120 r.p.m. has a rated capacity of 3,336 cu.ft. to 100-lb. pressure. The order was finally placed and the machine installed and put in operation.

The mechanical engineer of the Kingston Coal Co. relates the incident that he was in the compressor house when the new compressor was turned on to carry the load and the two discarded compressors were shut down, and that after it had been in operation about 30 minutes, the foreman of the boiler house rushed up to the compressor house window and shouted, "What in h— is going on here? Aren't you going to run the compressors today?"

THE RECORDS SHOW RESULTS ATTAINED.

After about two months of operation the following data, taken from the master mechanic's records, were submitted:

"The records show that the company has been able to shut down three 300-hp. B. & H. boilers. In the working day of 24 hr. it was able to save 48 tons of coal per day, which is valued at 40c per ton, making a saving of $19.20 per day on coal. The water meters show that it is saving $1.44 per day on water. It saves $5.28 on labor, making a total of $25.92 per day saved. As this plant operates continuously for 365 days per year, it makes a total net saving of $9,460.80 per year. In addition to this it has been able to dispense with $21,000 worth of boiler plant. It figures that the new compressor, installed on the foundation, cost $13,500.

The compressor was at first operated non-condensing, but later a condensing plant was installed, resulting in a still greater saving.

This company has recently installed a duplicate of this machine, and also an Erie City Lentz engine, which shows that it realizes thoroughly the saving that can be obtained by the installation of economical equipment, even in a region where coal is valued at only 40c a ton.

SEVERE TEST OF THE BRASHER AIR BREAKWATER

A little over a year ago it was questioned in these columns [Scientific American] whether or not Mr. Philip Brasher's invention would turn out to be of practical value when battling with the very exacting circumstances of an exposed seacoast. Prior to that time he had given his "breakwater" trials in more sheltered positions, and while the results were decidedly promising they were not of a nature to answer our query.

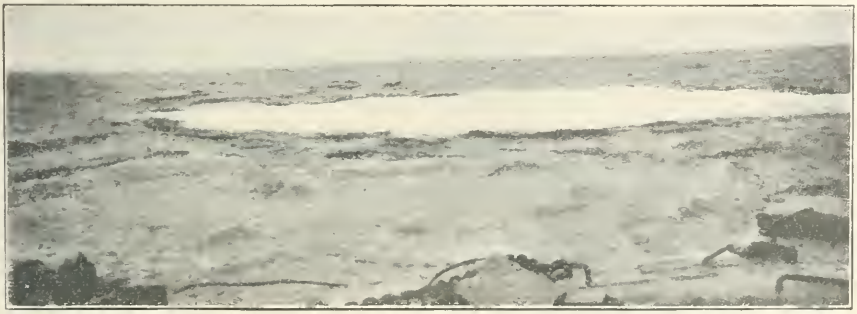
As can be recalled, during January just past, the Pacific coast was swept by a severe gale that destroyed much property along the shore and ravaged the sandy beaches to a wide extent. Among the structures exposed to the fury of the winds was a pier 2,100 feet long reaching seaward from El Segundo, California. A year before this wharf had been 4,100 feet long, but substantially half of it was then carried away by the waves during a violent storm. The structure was then so racked that it was not in a condition to witstand an attack of even lessened severity, and yet its maintenance was quite vital to the continuance of certain important shipping operations. It was to protect this pier from further harm that a so-called air breakwater was installed, and happily it was ready for service when the hour of trial came.

Fundamentally, the equipment was decidedly simple and consisted broadly of the following essentials. The seaboard end of the wharf has a width of 70 feet. Parallel with this and 145 feet farther out, 4-inch piping, perforated, was laid on the waterbed for a length of 120 feet. Each end of this was coupled up to smaller pipe leading back to the pier and was fed by two compressors, each having a capacity

4,100 FOOT PIER AT EL SEGUNDO, CAL.

of 1,000 cubic feet of air per minute. On each flank of the dock head was laid under water more perforated piping running parallel with the face of the pier for a distance of 100 feet, thus giving a total length of 320 feet of air breakwater. These flanking sections also drew their air from the two compressors, and they were designed to catch any seas that might get in around either end of the outlying 120 foot section.

When the storm came that was to put the installation to an exacting test the waves had a height varying between 12 and 15 feet, and were, undoubtedly, of ample size either to have wrecked a part of the dock outright or to have racked it harmfully. The pier was a costly structure and the owners might profitably have spent a good round sum to insure its security. During the worst of the storm and as long as the waves were big enough to threaten harm, the two compressors were kept going. This was for a period of 23 hours, and as the air bubbles rose surfaceward from the perforated piping they served to blast the billows, or, to be more exact, destroy the wave motion of their masses. As a result, the rollers seemed to drop as if their foundations had been knocked out from under them, and the remaining motion lacked sufficient surging force to disturb the supporting piles among



SMOOTH WHITE AREA CAUSED BY AIR DISCHARGE.

which they eddied as they spent themselves in their shoreward travel.

The compressors were located something like 2 miles away from the breakwater, and, allowing for leakage en route, it is probable that not more than 1,500 cubic feet of air was available for service at the perforated pipe. Under normal conditions, the air pressure need not be but a trifle in excess of the hydrostatic head, in this case the pipes were laid in 30 feet of water, but it so happened that the compressors at El Segundo were for much higher pressures and, therefore, more expensive to run. This added needlessly to the outlay, and yet for the 23 hours of continuous service the cost amounted to only about $60 Surely this was a very modest price indeed to pay for the saving of that pier.—*Scientific American*

PNEUMATIC CONCRETE MIXING, CONVEYING AND PLACING*

BY A. E. COMSTOCK.

On Section 5 of the Broadway-Fourth Ave. subway, which includes the two-track structure on 59th and 60th St. from Seventh Ave. east to Second Ave., the concrete lining of the tunnels and other structural concrete are both being placed by compressed air.

The machine used for this purpose is designed for both mixing and placing concrete. It consists of a drum about 4 ft. in diameter by 2 ft. deep, on the under side of which is attached an inverted cone-shaped section extending about 3 ft. below the bottom of the drum and terminating in a 6-in. discharge pipe. On top of the drum is a feeding hopper, and inside is a horizontal door, sliding in cams so adjusted that, in closing, it is brought tightly against a gasket on the top of the drum, thus making an air-tight lock. The door is operated by a hand lever connected to it by a piston rod passing through the drum

The cone-shaped section underneath the drum is fitted near its top and bottom with about 12 small inlet pipes, through which air is forced for the purpose of agitating the materials until they are thoroughly mixed before the mixture is driven through the discharge pipe to the forms. The discharge pipe is attached to the cone by a T-connection, from the free end of which a 2-in. pipe leads to the compressed-air reservoir, and another 2-in. air connection is located at the top of the drum.

When the process of mixing has ben completed, the air is turned on at both connections, the air through the upper one forcing the concrete down into the discharge pipe, while the air through the lower one forces the concrete forward to the forms.

When the machine was first put into operation on this contract, the agitators were not used, as it was thought that the materials would become sufficiently mixed in transit through the discharge pipe and upon being deposited in the forms. Repeated trials made by this method proved unsuccessful. The aggregates failed to mix properly with the cement and water and were deposited in the forms in a condition varying from very wet to dry. Being deposited under an initial pressure close to 100 lb., the materials that had become only slightly wet were compacted to such an extent that rehandling was difficult and involved considerable loss of time. Furthermore, an appreciable amount of sand and cement that had not come in contact with the water was blown clear of the forms. Later developments showed that dry materials had a tendency to clog the pipe more frequently than those thoroughtly mixed with water

Various methods and contrivances were used to overcome these difficulties and obtain a better mix, but without satisfactory results. An attempt was then made to use the agitators, but these were found to have become obstructed with cement to such an extent that it would have required a considerable loss of time to clear them. Moreover, it was the opinion of the engineers that the agitators would fail to do the work for which they were designed; for when the materials are placed in the mixer, they drop first into the discharge pipe and fill upward from that point, and all materials below the lower set of agitators would not be affected by them. Also, the agitators would act simply as an air inlet and would immediately cause the discharge of the materials from the machine before mixing could take place.

---

*Portion prepared by Mr. Comstock of a paper by Robert Ridgway, Engineer of Subway Construction, Public Service Commission, New York City. Read before the American Concrete Institute, Chicago, Feb. 14, 1916.

An arrangement was then made by which the materials could be thoroughly mixed to the proper consistency before being placed in the air mixer. This method, with proper spading and sufficient rehandling in the forms when necessary to insure an even distribution of materials, has resulted satisfactorily and is the method now being used. The arrangement of the plant at the mixing point was such that with a slight modification this method of mixing could be used continuously.

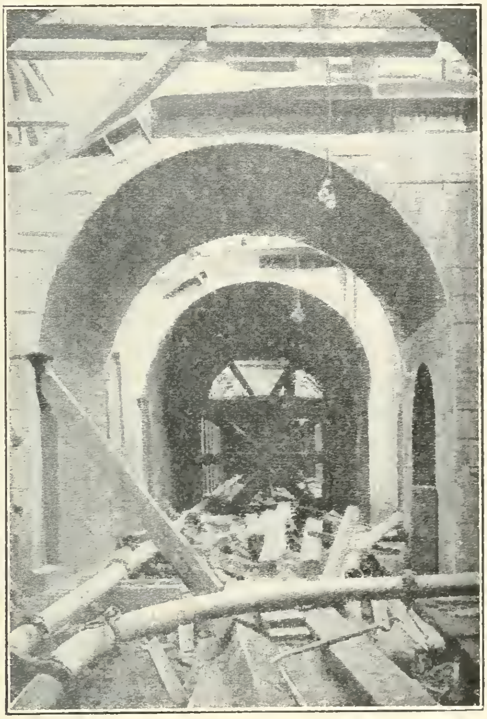
Two storage bins, one for sand and one for gravel, each with a capacity of about 12 cu. yd., are erected with their tops at the level of the street, in such a position that trucks discharge into them conveniently. At the bottom of each bin is a gate through which the materials are run into a hopper gaged for measuring the sand and gravel. At this point there is a platform, covered and water-proofed, where the cement is handled and temporarily stored, on which is located a water tank fitted with an improvised measuring gage and connected to a steam boiler for the purpose of heating in cold weather. The steam pipes also pass through the storage bins for the same purpose. At the bottom of the measuring hopper is one gate which, when opened, allows the sand and gravel, to which the cement has been added, to run together into the mixer.

Before experimenting with the air mixer, a rotating mixer had been in use in placing the track floor and wall benches. Space was provided in the arrangement of the plant to set aside one mixer in case it was desired to use another. Upon the failure of the air machine to mix properly, it was replaced by the rotating machine, lowered to a position above the air machine and so arranged that the rotating machine could thoroughly mix the materials and discharge into the latter with the previously mentioned satisfactory results.

ESSENTIAL DETAILS IN USING AIR FOR THE CONVEYING

The discharge pipe should be laid in the most direct line between the mixing point and the forms, avoiding bends as mush as possible, since all bends retard the passage of concrete through the pipe, encourage congestion and increase the time of transit as well as the consumption of compressed air. Where bends are necessary, they should be sweeps of large radii, about 15 or 20 ft. Short bends of 4 or 5 ft. were used on this contract in the early experiments with this method and were found to clog more frequently than those of larger radii and to wear through in a few hours, with consequent loss of time for repairs.

When the pipe becomes clogged, sounding at the point of congestion will usually loosen the the obstruction; but it is sometimes necessary to remove the obstructed part and clear it by other means. At every point where the pipe changes direction there is a decided shock when the concrete strikes the bend. It is therefore necessary to have such points securely braced, in order to prevent unnecessary strain on the joints, particularly at the outlet, where the shock would otherwise cause a shaking and consequent loosening and displacement of the forms, if there is any contact between the pipe and the forms— a condition that cannot always be avoided. The original position of the outlet of the discharge pipe should be located centrally in the forms, since each change of pipe means additional loss of time for bracing.



CONCRETE CONVEYING PIPES IN SUBWAY.

In passing through the discharge pipe, especially over long distances, the concrete has a tendency to spread out along the bottom rather than move in a solid mass through the full section of the pipe. If this condition continued to the outlet of the pipe, much of the air would pass over the materials, resulting in a loss of pressure, a longer time in discharging and a separation of materials at the outlet. In order to avoid this it is necessary to have a rise, vertical or nearly so, at or near the point of discharge, so as to cause the concrete to fill the pipe completely and to discharge more uniformly.

In order to obtain the proper distribution of concrete in the forms with as little rehandling as possible, a flexible rubber pipe was attached at the outlet, with the idea of directing the flow to different points, as desired. This proved practically useless, as the pipe buckled, was difficult to control and was soon worn out. It was therefore replaced by a T-connection that could be turned to any desired angle in a vertical plane and satisfactorily provided the required distribution.

This method of placing concrete is particularly adapted to filling tunnel arches, the discharge pipe being laid along the crown of the arch to about the middle point of length of the section and the T turned alternately on each side until the arch is filled to the level of the crown. The T is then removed and replaced by a piece of straight pipe extending to within a few feet of the far end of the form, the whole length of the pipe inside the form is raised to a position tight against the rock along the highest available line, and concrete is pumped in until the arch is filled up to the outlet of the pipe. The pipe is then removed and replaced by a shorter piece extending about 6 in. into the form at the most advantageous high point; the bulkhead is sealed and the blowing of concrete resumed until the arch is filled to the point of refusal. The pipe is left in place until the concrete has set long enough to be firm, when it is removed and cleared of any concrete remaining in it. It is impossible to seal completely all voids in the roof of a tunnel by this method of placing concrete, unless the rock breaks fairly smooth without leaving pockets above the general surface.

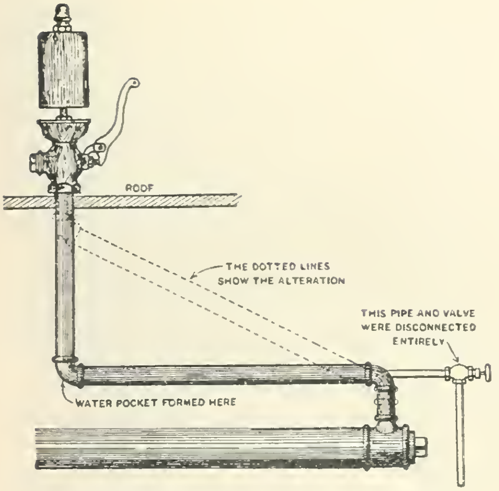
Care must be taken to avoid overtaxing the forms, as the high pressure of air added to the weight of the concrete is likly to displace or rupture them, and such an accident actually occurred at one point on this work. On this contract the point of deposit farthest from the mixer is about 500 ft.,and the time required to discharge a two-bag batch of concrete over this distance varies from 30 to 40 sec. Each batch is mixed for about 1 min., during part of which time the previous batch is discharged into forms. Under favorable conditions about 1½ min. are required to mix and place each batch; but on account of time lost in spading the mix in the forms, occasionally changing the position of the pipe, clearing obstructions and waiting for the proper amount of initial air pressure, a fair average between batches may be assumed as about 3 min. The time required decreases in length as the point of deposit approaches nearer to the mixer. It therefore requires about 12 hr. to line a section of tunnel roof 25 ft. long, which contains 80 cu. yd. of concrete, including excess.

At the present time there are two single tunnels each about 300 ft. in length, being constructed by this process. Part of this double tunnel is open-cut construction, where complete tunnel sections above the track floor, each 10 ft. long are being poured at one time as monoliths. The work is in progress at three points, thus keeping the machine in practically constant use. Steel forms and carriers are being used for tunnel sidewalls and timber arch forms on steel carriers for the tunnel roof.

USE OF COMPRESSED AIR FOR FIRE WHISTLES

. The illustration herewith, which comes from The Wm. Powell Co., Cincinnati, tells the story of a not unfamiliar experience when steam is used for a fire whistle.

"Some years ago," says the writer, "our town voted to put in an electric fire alarm, and as a large part of the firemen were "call" men it was thought advisable to have a steam whistle attached to the circuit, so that all the firemen might be notified of the fire when at their usual vocations. From the first there was trouble in not being able to count the blows on the whistle, so one day the chief engineer of the fire department asked me to take a look at the whistle and see if I could find out what ailed it. He said that the first blow and sometimes the second was so full of water that no sound came. Now I immediately disclaimed


ROOF
THE DOTTED LINES SHOW THE ALTERATION
THIS PIPE AND VALVE WERE DISCONNECTED ENTIRELY
WATER POCKET FORMED HERE

TROUBLE WITH STEAM WHISTLE.

any knowledge of fire whistles but met with the remark, "Well, you will look at it, won't you?" This I consented to do. I knew that it must be piped up right; the man who piped up the plant knew his business thoroughly, for I heard him say so, and so I reasoned that the fault could not lie with any of his work. But in thinking the matter over I decided in my mind where the fault was, and so took my spirit level with me when I went to examine the apparatus. The accompanying sketch shows the then existing state of affairs.

"Upon putting my level upon the whistle pipe I found that at the end of the pipe where it went up through the roof it pitched about two inches, making a pocket that was always full of water. Then there was a half-inch pipe leading to a receiver in the basement, but as the cut shows this was on the wrong end of the whistle pipe to be of any benefit, and when the whistle was blown, water was forced up from the receiver as well as from the pocket, and the total water must have been half a barrel, making a fine fountain but a poor whistle. Now, as to the remedy. My recommendation, which was adopted, was in the first place to disconnect the one-half inch pipe from the receiver, for as it is now used it would be unnecessary; and in the place of elbows put in forty-fives, so that any condensation would return to steam pipe as fast as it was made. Also to cover all piping thoroughly. Now the first blow is as clear as any, and there is no trouble. I am inspired to write of this experience because this same trouble has been reported to me as occurring in a neighboring town lately, and there may be others whom this may benefit."

The use of steam for a fire whistle calls for a constantly and instantly ready supply of steam especially at night and on Sundays, and we all know what such a requirement must mean, even when pipes and valves are all right. A good air receiver and a small electric driven or gasoline driven compressor would eliminate all trouble.

AIR LIFT SUGGESTIONS

BY JOHN D. KILPATRICK.*

For any number of wells, scattered as they usually must be over quite an area, the air-lift system has proven itself to be the most available method for delivering a large supply of water on the surface of the ground. It is not advisable, however, to use the air-lift (except under extraordinary conditions) for delivering the water higher than to the level of the ground. At best the air-lift is an expensive way of pumping, but where the water is obtained in large volume below suction limits, it would seem to be the only possible method. The air-lift system has the great advantage of not having any moving parts in the well, and there is absolutely nothing to get out of order in the air-lift itself. The moving parts of the system are all in the air compressor in the engine room, under the eye of the engineer. The engine room may be located at the most convenient point, and the farthest well may be a mile or more away from the air compressor.

If the air lines are correctly designed and properly laid, there need be but little loss of pressure. The main fault that the speaker has found with a great many air-lifts throughout the country has been in the air-lift piping in the wells. It is a familiar fact that a prime consideration for an economical air-lift is that there should be 60 per cent. submergence. For instance, in a 100-foot well, there should be at least 60 feet of water when the well is delivering its yield; but the principal trouble is found in the design of the air and water piping, so that the compressed air is delivered at the bottom of the uptake water pipe with as little loss by friction as possible, and that the uptake water pipe is designed so as to deliver the water, without being so large as to have an extreme amount of slip, or so small as to develop excessive friction.

---

*American Water Works Association.

Evidence of faulty design is shown by the discharge being in alternate pistons of water and air. In a properly designed air-lift system, the water should be discharged in a practically uniform stream, with very little surging. A great many foot pieces have been designed which have for their object the spraying of the air at the bottom of the uptake water pipe so as to introduce the air into the water in streams of very fine bubbles. It was discovered early in the development of the air-lift that the finer the spray could be made, other things being equal, the more efficient the air lift became; but no foot piece that was ever designed can work efficiently if the air pipe leading down to it and the up-take water pipe from it are not of such sizes as are suitable for the particular problem involved in that well. The great object to be accomplished by any foot piece is to offer as free and clear a water passage as is possible, so that there will be no eddies formed in the water column which cut down the velocity and impair the efficiency. Above the foot piece the mixture of air and water should have a pipe with as smooth surfaces as it is possible to obtain.

METHODS OF PIPING.

The three methods of piping wells may be termed: (1) The outside air pipe; (2) the inside air pipe; (3) the annular system. In the first case the air passes down outside the water pipe and into some type of foot piece or openings at the bottom with the water passing up through the inside of the water pipe. In the inferior pipe system the air passes down the inside air pipe to a foot piece or nozzle, and the mixture of air and water is blown upward between the outside of the air pipe and the inside of the water pipe. In the annular pipe system, one pipe is within the other, the space between the two pipes being the downtake air column, and the interior of the inside pipe being the uptake water discharge pipe. It is impossible, without an exact knowledge of the conditions, to determine which of these three systems it is best to use, assuming that the proper areas are available in each case for the amount of air necessary and the amount of water required to be lifted.

There are cases where the diameter of the well is so small and the amount of water to be delivered so large that there would not be room in the well for the outside air pipe in addition to the uptake water pipe. In this case, it might be better to use the well casing as the downtake air pipe and only provide an uptake water pipe. This arrangement, however, is sometimes impossible on account of air leakage through the joints of the well casing, which were opened up when the well pipe was driven. It is very hard to generalize and lay down rules for piping up wells on account of the different yields, depths and submergence of wells, and this is sometimes still further complicated by the number of wells that have to be pumped.

With a great number of wells to be pumped from the same air compressor, very delicate adjustments are required, so that all the wells may be started at the same time. The speaker believes that it is preferable to use a single air line, with outlets to each of the wells, rather than separate air lines from the pump house to each of the wells, both as a matter of economy of installation and economy in the use of air. The plea sometimes made that independent air lines to each well allow of adjustment within the engine room is invalid because the place to adjust the well is at the well itself, and if the plant is properly designed originally it should not be necessary to adjust the wells except at considerable intervals of time, and then only because of the increased requirements made on the plant, or fluctuations in the wells themselves.

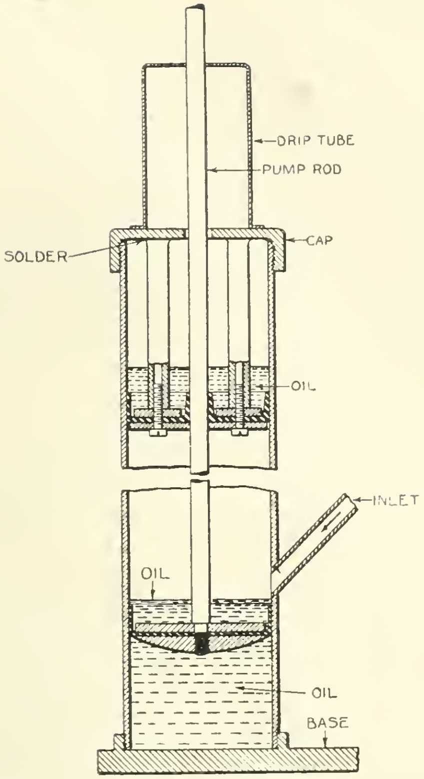
BENEFIT OF HIGH PRESSURE GAS FEEDING

Seeing that compression of gas condenses out much water vapour, naphthalene, etc., from gas, W. H. Bennett, gas engineer of the Redhill Gas Co., suggested in a letter printed in "Gas," of London, last December, that it would be wise to deliver a certain amount of high pressure gas through governors into the low pressure system as a means of alleviating naphthalene troubles. He remarked that while lately he had had, like many engineers, much trouble from a recrudescence of such stoppages, his district was quite immune in the parts supplied from high pressure mains. A striking confirmation of the value of this suggestion comes from Bergen. In the severe Norwegian winter the freezing of condensed moisture, especially if naphthalene crystals are also embedded in the mass, is a very great source of trouble to gas engineers. Engineer Schieldrop finds that though his low pressure mains are subject to this trouble, he gets no such deposits in the districts fed from high pressure mains; consequently he now uses as great a proportion of high pressure gas as possible in his low pressure mains, and is fully justified, he says, by the results.—*Gas Record.*

A SIMPLE VACUUM PUMP

BY CHARLES E. DURYEA.

Often a good vacuum is required and no ready means at hand to produce it. In these days of cheap pumps for auto tires a good vacuum pump can be easily made. Select a pump with a screw cap and a long barrel which may be unscrewed from the base. Close the outlet in the base and solder an inlet tube in one side of the barrel about two inches above the bottom. This inlet tube should extend outward and upward at about 45 degrees so that any oil which may enter it will return to the barrel. The leather cup on the pump rod should be turned over so as to act on the pull stroke. Fit a similar cup two or three inches below the top, which may be supported from the top cap by two or more short rods soldered to the top and the metal parts which hold the cup. The cup leather for this cup should be stretched up in its center so as to form a packing around the pump rod. If a cup already with a hole through it is used a second layer of leather may be added to make this rod packing. On the top of the cap solder a tube about two inches long to catch any oil the pump rod may carry out with it. The pump rod fits loosely in the hole through the top so the air can get out alongside of it freely and any oil can run back easily. Screw the bottom on the barrel, pour some oil into it and insert the parts. Depress the piston cup as far as it will go. The oil should more than fill it. Raise it as far as it will go and the excess comes into the top cup, and partly above. There must be no hollows on the underside of either cup to hold an air bubble. If a little more certainty is desired at this point conical nuts can be used to grip the cups and they may extend to the barrel walls.



HOME-MADE AIR PUMP.

The down stroke now starts with no air between the cups and an oil seal to both cups. Little imperfections of the cups do not matter if the oil is fairly heavy, as for example gas engine cylinder (auto) oil. The space between the cups fills with air from below which meets some resistance forcing its way past the cup and oil until the cup passes below the inlet tube, when this resistance is away and the barrel has a vacuum equal to the vessel being exhausted. The piston cup sinks into the oil below, filling itself again to normal level, and begins to carry the air above it as soon as it passes the inlet opening. At the top it empties completely, forcing such oil as has leaked in from the top cup, up into it again.

Most air pumps fail when there is no longer enough air remaining to lift the valve, and a very light valve takes a surprising amount of air to lift it. This pump has a perfect vacuum between the cups when this non-raising condition is reached, and as soon as the piston cup passes below the inlet this vacuum fills from the exhausted space with no resistance whatever. Possible air bubbles and a slight oil vapor seem to be the only dangers. If the last strokes are made slowly and with some interval between, the bubbles will float to the top and pass into the cup above with the excess oil. If oil vapor is feared boil the oil till all low test vapor passes off. The space above the top cup should be long enough to hold the oil in it without spilling when the pump lies flat. The oil-catching tube may have a flange inside its top end for the same purpose.—*Scientific American Supplement.*

CARELESSNESS KILLS

From a Coal Age collection of narratives of accidents caused by carelessness we select the following which, after the event, seems scarcely credible:

At a certain mine the slope hoisting engineer is required to look after two large air compressors, which are in the engine room, in addition to his duties as hoisting engineer. The slope is approximately 600 ft. long and is used exclusively for hoisting and lowering men. A covered cage is used and of such a type that it is impossible for more than one man to get in or out at the same time. The distance from the mouth of the slope to the engine house is about 100 ft. While the engineer was engaged in hoisting a cageload of men, something went wrong with one of the air compressors, requiring his immediate attention. Instead of stopping the cage and then looking after his other work, he left the engine while it was running and went to the compressor. He probably thought it would take but a moment to fix the compressor, and as the hoisting engine was running slowly, he would have plenty of time to spare. Perhaps he had done the same thing before. However, the air compressor required more attention than he anticipated. The shouts of the men as the cage was dragged through the space between the mouth of the slope and the engine house called his attention to the throttle. Before the engine was stopped, however, the cage crashed through the side of the building and over the hoisting drum, resulting in the death of one man, the father of a large family, and several other men were injured.

DELAY CARTRIDGES

A safety feature for those engaged in blasting is the use of what are called "delay" cartridges, which enable a blaster to count all the holes in a round and make sure that all have gone off. In the first hole an ordinary blasting cap is put. The second hole is fired by a delay blasting cap, the third hole by a second-delay blasting cap, the fourth hole by a third delay blasting cap, and so on. All the caps are on the same circuit, and all are ignited by one operation of the blasting machine. The delay caps fire the charges in order, and with a sufficient interval between explosions to permit of counting the shots, so that the men doing the blasting can tell absolutely that every charge has gone off before they return to the cut.

POWER-PLANT LOSSES AT HIGH ALTITUDES

BY A. VINCENT CLARKE

The pressure of the atmosphere at sea level is 14.7 lb. per sq. in. At lower depths it is increased, and at higher elevations it is less. This reduction of the atmospheric pressure at high altitudes must be taken into account before power plants are installed in such places.

With steam plants the boilers cannot generate as much steam as it is possible to do at sea level, for owing to the rarity of the atmosphere the same volume of air contains a smaller weight of oxygen, and for the same velocity of air through the grates and flues a much slower rate of combustion is obtained.

Considering the engine alone, the working at the high elevation is beneficial because, owing to the reduction of the back pressure, the same quantity of steam at the same pressure as at sea level will develop greater power than can be obtained at sea level. [It must be remembered that absolute pressure, and not gage pressure, is here spoken of. Ed. C. A. M.] With noncondensing engines this is most apparent, for at an altitude of 10,000 ft. above sea level the reduction in the back pressure is equivalent to the addition of nearly three pounds to the mean effective pressure on the low-pressure piston.

To obtain the same evaporation from a boiler at a high altitude as can be obtained at sea-level, it is necessary to use forced draft, but the employment of this might increase the velocity of the air and gases through the grate and flues to such an extent that the operation of the boiler would become uneconomical and it would be better to have a larger one.

Oil engines working at high altitudes cannot develop the same power as at sea level, owing to the smaller weight of oxygen contained in the cylinder. The amount of fuel oil that can be consumed, assuming perfect combustion, is in proportion to the quantity of oxygen present in the cylinder, and because the piston displacement is unalterable, the weight of oxygen in both cases will be in a ratio to the densities of the atmosphere.

The atmospheric pressure at various altitudes is given in the chart, Fig. 1. At an elevation of 10,000 ft. the pressure of the atmosphere is about 10.3 lb. per sq. in. Thus at this altitude the engine cylinder will, at the commencement of compression, be full of air at a pressure of 10.3 lb., whereas at sea level the same volume of air would be present at a pressure of 14.7 lb. The amount of oxygen would be in the same proportion in both cases, so that the power obtainable would be in the ratio of 14.7 to 10.3, giving a loss of about 29 per cent. at the high altitude.

With internal-combustion engine plants intended for working high above the sea level, the lower pressure of the atmosphere will also affect the working of the engine by reducing the compression pressure unless provision has been made for overcoming this. The absolute pressure obtained at the end of the compression stroke, if there is no leakage past the valves and piston, is equal to

$$p_1 \times \left(\frac{V}{v}\right)^{1.35}$$

where

p_1=Absolute pressure at the commencement of the stroke;

V=Total volume—that is, the piston displacement—clearance;

v=Clearance volume.

From this it is seen that if the initial pressure is reduced, then the compression pressure will be lower, and as the satisfactory running of the engine depends upon the maintenance of approximately the compression for which it was designed, it follows that either p_1 must be increased by artificial means or the ratio $\frac{V}{v}$ must be increased. In practice the latter method is adopted and is effected by either lengthening the connecting-rod or making a new combustion chamber having a smaller capacity; thus the compression pressure becomes the same as that obtained at sea level, but the volume of air is less, consequently the same amount of fuel cannot be consumed and the power is reduced.

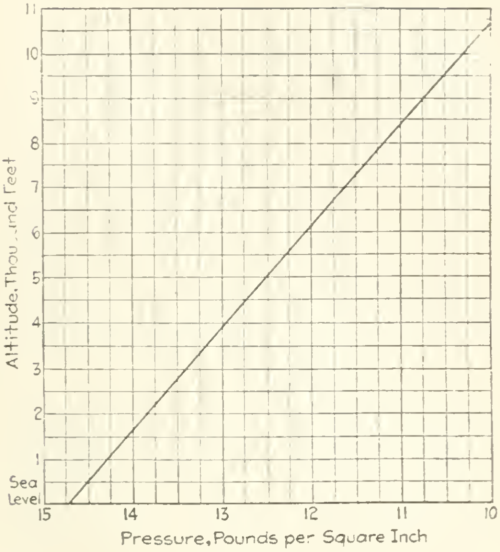


FIG. 1.

Were it practicable to increase the initial pressure in the cylinder to that obtained at sea level, there would be no loss of power at the high altitudes; this result, however, could be obtained only at the expense of the simplicity of the plant, and in addition to the cost of the extra gear, there would be a certain amount of power required for operating it.

For suction-gas plants a larger producer than is required at sea level would be necessary, and it would be problematical whether it did not become a pressure producer after the apparatus for producing the draft and the pressure regulator had been added.

The fuel consumption at high altitudes will be approximately the same as would be obtained when working at the same power at sea level; thus the amount of fuel used by an engine at an elevation of 10,000 ft. when working at its full load will be about the same as would be consumed at two-thirds of its full load rating at sea level.

Diesel engines require a larger compressor for the air used for the injection of fuel when

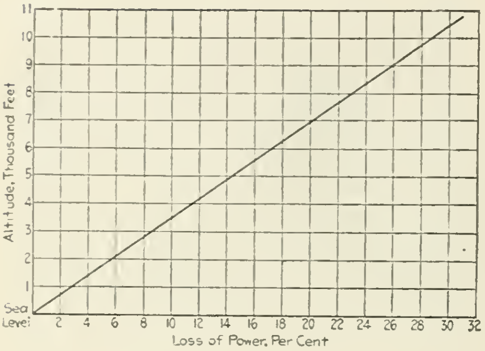
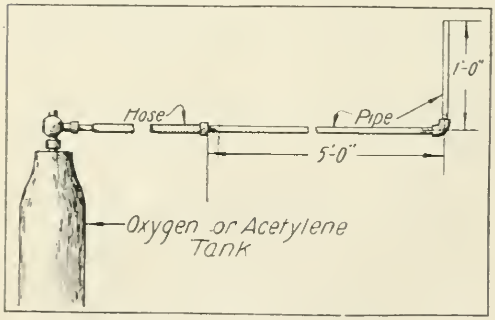


FIG. 2.

working at a high altitude than is necessary at sea level, as it is essential for their satisfactory operation to have the same volume and pressure of air as at sea level.

The loss of power that occurs with internal-combustion engines at various altitudes is shown in Fig. 2, and as the atmospheric pressure can practically be represented by the straight line shown in Fig. 1, it is apparent that the loss of power can also be represented by a straight line.



FOR THAWING TAP HOLES.

THAWING FROZEN STEEL

Everything which melts by being heated will also freeze agin when the process is reversed, although by thoughtless habit we are apt to regard the phenomenon as belonging to water alone. The range of freezing temperatures is practically the same as that of melting temperatures Liquid air, which looks so much like water, freezes and forms air ice at a temperature about 375 degrees lower. Alcohol freezes at—203 deg. Fahr., Carbonic acid at—108 deg., mercury at—39 deg. Towards the other end of the list iron freezes at about 2,000 deg., and the formation of cast iron ice on the surface of the metal in the ladle is a familiar sight in the foundry.

The freezing of steel occurs at a temperature higher than that of cast iron, and when it occurs in the tap holes of melting furnaces ingenuity has been taxed to devise means to thaw it out again. Mr. T. W. Dagnall writes about this in a recent issue of Foundry. Among the many annoyances of steel foundry operations, he says, are frozen nozzles or frozen tap holes. These are quite frequent occurrences and they are exceedingly costly. In the accompanying illustration is shown a device for thawing out frozen nozzles and tap holes, which has proven quite successful. A piece of ½-inch pipe, about 5 feet long, is coupled to an elbow to which a piece of pipe 12 inches long is attached, thus forming an L-shaped section. To one end of the 5-foot pipe is attached a hose which connects with an oxygen gas tank. The section of 12-inch pipe then is inserted in the nozzle, the gas is turned on and in less than 60 seconds the nozzle is freed from obstruction and the heat can be poured without further trouble. This same contrivance can be used for thawing-out the tap hole of the melting furnace, with the exception that it will be more convenient to employ a straight piece of pipe for this work. When it is considered that a great many heats in steel foundries are lost through frozen nozzles and tap holes, it would seem to be advisable to have a device of this kind as a part of the shop equipment.

COST OF CEMENT GUN WORK*

The upstream face of the Elephant Butte dam of the United States Reclamation Service is being waterproofed with portland-cement mortar mixed in the proportion of one part cement to two parts sand and applied with a cement gun in a coating about 1 in. thick. Advantage has been taken of rising water in the reservoir to work from rafts specially constructed for the purpose. There are two of these, each 9x13 ft., made of planking on a framework laid on and attached to 16 oil barrels. One raft contains the machine, operator and helpers, small mixing box and a few sacks of cement and sand, while the other is loaded with cement and sand.

The coating is applied in horizontal strips about 10 ft. high and the length of the dam at water level. The surface is first cleaned thoroughly with scrapers and wire brushes and is then gone over with a sand-blast, using coarse sand, passed through the machine to obtain the necessary pressure. This roughens the surface sufficiently to cause the mortar to adhere to it. The surface is then thoroughly moistened with a hose and the mortar immediately applied. The mortar is put on in four layers, each about ¼ in. in thickness. It was found that a thicker coat than this applied on a vertical wall, without reinforcement, would, on account of its weight, slough off before setting. Each layer follows the preceding one before it has attained its final set, and so far there is no indication of a parting of the layers. Numerous samples taken from the face showed perfect adhesion to the concrete, it being impossible in every case to break the mortar from the concrete at the line of contact. The cost per square foot for the first 100,000 sq. ft. of this coating is as follows:

---

*Reclamation Record.

Operating and repair work, including cost of air and water	$0.015
Staging, cleaning wall, moving, etc.	.006
Cement	.024
Sand, including labor, screening and hauling (sand only 20c per cu. yd.)	.007
Depreciation of gun and equipment	.020
Subtotal	$0.072
Overhead	.007
Total cost per square foot	$0.079

Some experiments were also conducted at Elephant Butte to determine the feasibility and probable cost of troweling the mortar placed by cement gun, with the idea of using the machine for the lining of canals or for repairing lining that had disintegrated and required a smooth finish. The area treated was 75 sq. ft. This was covered with mortar averaging ¾ in. in thickness in 15 min. working time, or at the rate of 300 sq. ft. per hr. for this average thickness. One good finisher troweled 56 sq. ft. in 25 min., or at the rate of 135 sq. ft. per hr. Possibly two men could keep up with the gun. The finishing was not done to a screeded surface. The surface is wavy, but much smoother than a formed surface would be. It could be screeded to a plane, if thought necessary. Care must be taken that too much material is not deposited in one coat, or horizontal cracks will occur, due to settlement. Some cracks appeared in this experiment, and in each one the material was found to be from 1 in. to 1½ in. thick. The cost of this particular experiment, not counting cost of setting up, equipment, etc., was as follows:

Labor	$0.30
Sand, approximately 9 cu. ft.	.90
Cement, 4 sacks	2.00
Total for 75 sq. ft.	$3.20
Per square foot	$0.04¼

Depreciation, staging, moving, etc., would depend on the job, but it is probable that the total cost of placing this coating, including the troweling, under average conditions would not exceed 5c per sq. ft.

In using the cement gun the sand must be clean, sharp and not too fine. It must not be bone-dry, or trouble with feeding will occur. The air pressure should be about 30 lb. in the gun and the water pressure over 60 lb. It has been figured at Elephant Butte that 30 ft. of free air at 100 lb. pressure at the point of delivery to the gun and 10 gal. of water are required per minute.

POWER DISTRIBUTION IN VERTICAL BLOWING ENGINES

Mr. S. P. Baird in Practical Engineer, April 1, calls attention to the distribution of power and work in each blowing stroke of a vertical steam driven blowing engine The blower cylinder as described seems to be single acting, and if the steam cylinder were also single acting—which of course it is not—the description given of the phenomena occurring might apply, but what would happen during the return stroke? To satisfy the description we have to assume that there were duplex cylinders, both steam and air, with cranks opposite so that the pistons on one side would descend while those on the other side ascended, and for each blowing stroke each steam cylinder would contribute half the power. Similar fluctuations of the balance of steam pressure and air resistance in straight line horizontal machines have long ago been noted.

We have laid down in some of our books, he says, that steam compression should be carried to a point as near boiler pressure as possible. I was always a great believer in compression as a money saver, and as an aid to smooth running; but I came across one type of engine in which it was impractical to have any compression or, in fact, any lead. To secure smooth running, the diagram should show no compression and a negative lead on the bottom end.

The engines in question were upright blowing engines used to blow Bessemer converters. They were 36 by 48 in. with Corliss hand-regulated releasing valve gear. The blowing cylinders were in line with the steam cylinders and the 2 pistons were directly connected. The air was admitted and discharged from the air cylinder by valves similar to pump valves and normally closed by light spring pressure. There was considerable clearance in the air cylinder, as much as 10 per cent., and the pressure on the blast pipe was 28-lb. gage. The pressure in the air cylinder would continue to rise until it reached the pressure in the blast main—28 lb.; this occurred when the piston had reached approximately ¾ of the stroke, and this pressure continued until the piston reached the end and started on the return stroke.

Now, the idea of compression from a smooth running standpoint is for the purpose of overcoming the inertia or power stored in the rapidly moving reciprocating parts of the engine; but with a tandem compressor, there is already a force acting to stop these reciprocating parts so there is then no necessity for compression on that score. From the economy standpoint the idea is all right, but practically it won't work; because the pressure in the steam cylinder is rapidly diminishing at the time when the pressure in the air cylinder is at its highest, and the difference between the power consumed and the power generated must be made up by the fly-wheels. To have a compression pressure built up at the end of the stroke would stop the engine on the center, and for the same reason there can be no lead.

There is another peculiarity of this type of engine. It is a well-known fact that the guides of ordinary engines are worn most in the center; but with an upright tandem compressor the wear is mostly at the ends, or rather near the ends. The steam pressure being high during the early part of the stroke, with a low air pressure, the surplus energy is stored in the flywheels. This pushing on the connecting rods puts considerable strain or pressure on the guides. At about ½ stroke, the energy consumed equals the energy generated and the flywheels are just floating, neither absorbing nor giving off power; but a little farther in the stroke, the energy generated is growing less while the energy required is increasing and this difference must be made up by the flywheels, thus causing extra pressure on the guides at about ¾ of the stroke due to the push of the connecting rods by the flywheels driving the load. With the next half of the cycle the same things take place, only the pressure on the guide is in the opposite direction and consequently on the other guide. The net result is practically no wear on the center or the ends of the guides; but between the center and the ends, there is a zone of wear on both sides of the center of both guides and of about the same amount.

BIGGER THAN THE RAILROADS

To the average citizen, a great railroad system represents one of the largest aggregations of capital and resource, but a railroad is really one of the small potatoes in comparison with certain commercial establishments. Take, for instance, the Willys-Overland Company, controlling an automobile plant, two tire factories and one starting and lighting plant. This aggregation of energy and capital was not in existence ten years ago, but it expects during 1916 to do a business of $250,000,000. One of the big packing companies, during 1915, handled a business of $500,000,000. In contradistinction, the Southern Pacific Company, operating over 12,000 miles of railway and several steamship lines, with property approximating $909,000,000, and with possibly 40,000 employees, is fortunate if it can earn a gross return of one-half of that of the automobile concern. The manufacturing plants pursue the even tenor of their way and pile up their remarkable net earnings with a proper protection of their resources and revenue; but poor Mr. Railroad is hammered from early to late; shot at, turned inside out, sat on and otherwise made to mark time by the public.—*Southern Pacific Bulletin.*

A soap bubble blown at the Royal Institution, London, by Sir James Dewar on February 17th burst on March 24th, after an existence of five weeks.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE
Compressed Air Magazine Company
Easton, Pa.
New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. MAY, 1916. No. 5

CONTENTS

Subway Excavating Revolutionized..... 7971
Machine Drilling in Alaska............ 7976
Compressed Air Pulls by Pushing...... 7978
Gasoline Locomotives bad for Mine Air 7978
High Class Equipment Saves Money.... 7979
Brasher Breakwater on the Pacific Coast 7980
Pneumatic Concreting 7982
Compressed Air for Fire Whistles...... 7984
Air Lift Suggestions.................. 7985
High Pressure Gas Feeders............ 7986
Simple Vacuum Pump................ 7987
Carelessness Kills 7988
Power Losses at High Altitudes........ 7988
Thawing Frozen Steel................. 7990
Cost of Cement Gun Work.... 7990
Power Distribution in Blowing Engines 7991
Bigger than the Railroads.............. 7992
Progress 7993
Rights of Weighers and Measurers.... 7994
Cracking of the Hydrocarbons......... 7994
Blasting with Liquid Air............... 7996
New Turbo Blower.................... 7997
Pneumatic Tie Tamper.................. 7997
Notes 7998
Patents 8000

PROGRESS

A bill has been instruduced in the House of Representatives of the Congress of the United States by Mr. Dillon of South Dakota and referred to the Committee on Coinage, Weights and Measures and ordered to be printed, the full title of which bill is as follows:

A BILL

"To establish the metric system as the standard for weights and measures, and for "other purposes."

The attitude and animus of the originators and pushers of the bill are sufficiently indicated by section 4, which reads as follows:

"Sec. 4. That any person, corporation, company, society, or association who shall use, or offer and attempt to use, in any industrial or commercial transaction in the sale or purchase of any commodity any other weights or measures than these of the metric system on and after July first, nineteen hundred and twenty-four, shall be guilty of a misdemeanor, and upon conviction thereof in any court of competent jurisdiction shall be punished by a fine of not more then $500 or by imprisonment for not more then three months, or by both such fine and imprisonment."

This shows how times have changed. Here surely is progress. Time was when, in the Old World, a crime of the magnitude here suggested would have been punishable by hanging or decapitation. But this is the New World, the Twentieth Century, the United States of America

RIGHTS OF WEIGHERS AND MEASURERS

In the current discussion of the metric system, as is always the case, the secondary function of the system is accorded undue importance. Weights and measures are primarily for weighing and measuring, and the weighers and measurers should have the first right to say what they shall use for their work. It happens, however, that, although the physical workers of the world, the actual weighers and measurers, outnumber the recorders and computers perhaps a hundred to one, and in the multiplicity of operations in which weighing and measuring occur a thousand to one, they are not the talkers and writers, and so their views and wishes are not presented and defended as they should be, and too often are turned down without a hearing when offered.

The typical and most persistent advocate of the metric system is, after all, only a secondary user of it, the college professor, who never works on Saturdays, who has various vacations in between, with three months in the summer and his sabbatical year for rest and recuperation. Surely he should be relieved from the brain-fag which accompanies the handling of feet and inches, pounds and ounces, cubic feet and gallons, and he is not backward about saying so, but the worker might tell him that it is very little of his business, anyway.

Our workers are not ignorant of the characteristics of the metric system. They know full well that it is not as "scientific" as it claims to be, that it is a scientific failure in not providing facility of continued subdivision by two, and especially by three, which is often so necessary in actual work, and so they prefer, and are likely to continue to use, in their work and in their intimate and most numerous trading, the systems which are most convenient to them.

Just now the argument most persistently urged for the adoption of the metric system—compulsory, of course, for it has never been generally adopted anywhere by free choice—is that it would be an important and valuable feature in securing trade with the metric countries. Every manufacturer and every trader has absolute liberty even now to work to the metric system and to use it in any of his transactions. There is no evidence that one cent of foreign trade has been lost by his failure to do so, and if he has failed to get the metric trade, who is to blame?

This foreign-trade argument might be urged in the opposite direction by ardent protectionists. By all means let us retain our present "incongruous and unhandy" weights and measures, to deter the manufacturers of the metric countries from producing goods to meet our markets. How much have Germany and France been troubled about our weights and measures when seeking our trade or that of England? The argument is equally absurd when urged in either direction

The attempt to cram the metric system is more than anything else an outcropping of a familiar human trait. It is orthodoxy, or my doxy, trying to down heterodoxy or your doxy, so that we may pat ourselves on the back over it. There are no substantial pecuniary interests to be served except in opposition. —FRANK RICHARDS, *Evening Post, N. Y.*

THE CRACKING OF THE HYDROCARBONS

The following we take from Bulletin 114 recently issued by the Bureau of Mines. Its full title is: Manufacture of Gasolene and Benzene-Toluene from Petroleum and other Hydrocarbons, by W. F. Rittman, C. B. Dutton and E. W. Dean, with a Bibliography compiled by M. S. Howard. There are 268 pages with many illustrations. It embodies a large amount of careful work, is a valuable addition to our stock of technical information and should be of great value to workers and investigators in the line which it carries

ORIGIN AND DEVELOPMENT OF CRACKING PROCESS.

The cracking process, so-called, may be said to date from its accidental discovery at Newark, N. J., in the year 1861. Essentially it consists in heating oils to such a temperature that their heavy molecules decompose into lighter molecules with the production of mixtures of lower boiling point.

FIRST APPLICATION OF CRACKING PROCESS.

As originally employed, the process was directed toward the conversion of that fraction of crude petroleum intermediate between the burning of kerosene oils and the lubricating oils into liquid hydrocarbon products of lower density and boiling point, which would be suitable for use as illuminants. An open still was used, so that partial condensation of the vapors could occur in the upper part of the still permitting more heat to be supplied to the boiling liquid, with consequent increase in its temperature and the desired decomposition into products of lower boiling point.

CHEMICAL NATURE OF CRACKING PROCESS.

The cracking process is simply one instance of the well-known tendency of organic substances to decompose on the application of heat. The heavier the hydrocarbon molecule, the more easily it is dissociated. In actual fact, cracking to a greater or less degree is the rule rather than the exception in the majority of distillation processes involving more than moderately low temperatures. In 1868 it was pointed out that, during the distillation of hydrocarbons on a commercial scale, cracking always takes place to some degree.

A natural hydrocarbon oil, or crude petroleum, is a mixture of substances of varying boiling points. Each of the hydrocarbons of high boiling point contained in such mixtures is, during the process of distillation, exposed to various degrees of temperature below its own boiling point, so long as the hydrocarbons of lighter gravity and boiling point are not removed from the still. Consequently, the liquid hydrocarbons of high boiling point may remain exposed in the still to temperatures below their boiling point for a number of hours. For example, in refinery practice, one to three days is necessary to complete a crude distillation, the exact period depending on the size of the still and the amount of hydrocarbons to be treated. This long exposure to a degree of heat below the boiling point of a particular hydrocarbon, resulting in its dissociation or partial alteration, constitutes "cracking." As time is an important factor in every organic reaction, the technical significance of the time the oil is exposed to heat becomes evident.

TEMPERATURE AND PRESSURE.

In the cracking of heavy oils two factors govern largely the course of the reactions that take place, namely, temperature and pressure. The function of increased temperature is to break the bonds of groups that make up the complex hydrocarbon molecule. In many processes pressure is of chief importance in controlling the temperature of distillation, but it also exerts an influence on the nature of the decompositions produced.

The temperature at which dissociation takes place with the desired rapidity is usually above the boiling point of the hydrocarbons concerned. When no pressure is employed these hydrocarbons will vaporize and pass out of the reacting sphere, the degree of alteration being small. If, however, sufficient pressure is employed to raise the boiling point to a temperature causing more rapid cracking, alteration into desired products may be obtained with a minimum of total decomposition. As soon as the action begins to be total decomposition, permanent gases will be evolved and both carbon and heavy asphaltic bodies will remain as residues. The volume of gas, therefore, if measured, is an approximate index of the degree of decomposition that is taking place.

OBJECT OF CRACKING PROCESS.

The cracking process involves, therefore, a partial alteration or dissociation, as distinguished from a more complete alteration or decomposition. The object of cracking is to alter the heavier molecules so that low-boiling hydrocarbons will be produced that would not appear on ordinary distillation. Such a process may or may not be accompanied by an appreciable production of permanent gases, depending on the degree of alteration necessary to obtain the desired products. In a simple cracking process as high a temperature as is practicable within the limits of the apparatus is desirable, in order to insure a high speed of reaction. A decrease in temperature below a given point will mean a decided increase in time. In commercial practice this would mean increase in operating costs. On the other hand, too high a temperature will mean a large production of extreme decomposition products, so that for results desirable commercially a mean temperature must be chosen that will cause the process to be completed at the maximum speed consistent with a relatively small production of permanent gases and carbon. This consideration has been emphasized by Engler and Hofer, who point out that, for the splitting of heavier petroleum hydrocarbons into lighter products, excessively high temperatures are not advantageous.

COMMERCIAL VALUE OF CRACKING PROCESS.

Liquid-phase cracking processes, though extensively used for the production of illuminating oils and motor fuels, are as yet in the primary stages of commercial application. As a means of supplying the products most in demand, their importance can hardly be overestimated. They served their purpose well for producing burning oils, when these were the most desirable products, and are now being adapted to the production of gasolines and naphthas. It only remains to discover the most efficient means of obtaining the maximum possible percentage of the desired product from any particular oil. The ease and cheapness with which crude petroleum can be transported to regions lacking supplies of crude oil give particular value to cracking processes, as the cheapest and most readily obtainable oils may be subjected to cracking at the place of the greatest demand and most extensive use.

LATEST DEVELOPMENTS IN BLASTING WITH LIQUID AIR*

The first experiment with liquid air as an explosive dates back nearly to the beginning of its industrial production. Prof. von Linde made an explosive called "Oxyliquit" by mixing liquid air with charcoal. This explosive broth, or paste, was put directly into the drill hole and fired by means of cartridges and fuses.

Since this primitive method gave unsatisfactory results, it was modified by filling a suitably prepared cardboard cylinder with an explosive substance, preferably by dipping the whole in liquid air. This method gave results, but was lacking in safety, and depended on the skill of the workmen and quickness of manipulation. The trouble was due largely to the enormous difference in temperature between the liquid air and the surrounding rock, so that the air rapidly evaporated in the hole. The maximum theoretical life of a blasting cartridge was thus only 10 minutes, while in practice it was still shorter.

Interesting experiments have been made in France by Georges Claude, and other experiments which improve upon the von Linde method have been conducted in Charlottenburg, Germany, by Kowatsch, with the co-operation of von Baldus.

In order to prevent a rapid evaporation of the liquid air, Kowatsch puts the cartridge with the dry carbon container in the drill hole before introducing the liquid air, and avoids the dangerous loss of time by necessary preparations, such as tamping the hole after the mixture has been made. The liquid air is not introduced until time for shotfiring. This reduces the evaporation period to a minimum.

The cardboard cylinder contains a perforated partition tube, in which is placed a perfectly innocuous mixture of infusorial earth and oil or asphalt, or of soot and paraffin. The central partition tube encloses a cardboard tube, over which is thrust another cardboard tube to serve for carrying off the evaporation product of the liquid air. If several holes are to be fired at once, the electric wires are connected.

The liquid air intended for each hole is provided in a suitable quantity in a small flask, to the opening of which is attached a metal tube with a conical point, into which tube is introduced the central tube of the cartridge. To charge the cartridge, it suffices to raise the back end of the flask. The liquid air is then lifted by pressure of its evaporation products (just as water containing gas is lifted by pressure of carbonic acid) in the metal tube, and is forced into the cartridge. At the moment when the shot is fired by an electric fuse, the liquid air combines with the components of the charge and causes an explosion of extraordinary energy.

A NEW INGERSOLL-RAND TURBO BLOWER

The Ingersoll-Rand Company has added to its Turbo Compressors and Blowers a low pressure machine to handle volumes from 3,000 to 35,000 cubic feet per minute at from 1-2½ pounds. These are particularly adapted to such service as foundry cupola blowing, atomizing oil for oil burners, supplying blast to heating and annealing furnaces of various kinds, blowing air for water gas generators, pneumatic conveying and ventilating. They are of the single stage, double flow type, and are furn-

---

*From an article by M. Przyborski, mining inspector, Budapest, Hungary, in the *Montanistische Rundschau.*

ished either electric motor, steam turbine or water wheel driven. Electric drive is generally employed for the classes of service above mentioned, and the high operative speed permits direct coupling to motor, a first cost economy. The motor driven I-R Turbo blower maintains constant pressure, while delivering any volume from zero to maximum demand and proportionately varying the electrical horse power input.

These blowers embody the four-bearing construction featured in all the Turbo machines of this make. The casing is horizontally parted for convenience in installation and inspection. The assembled casing is doweled and bolted to a heavy sub-base, which ordinarily serves for both blower and driving element. The I-R Turbo occupies small floor space and its vibrationless operation obviates the necessity for foundation bolting. The impeller is of the enclosed double flow type, claimed by the manufacturer to secure the highest efficiency. The wheel is machined from a solid, special steel forging. Vanes and covers are of pressed steel securely riveted. All rivet heads are driven flush and the entire assembly polished. Every care is taken to reduce skin friction. All impellers are overspeeded in a testing machine to insure correct balance, strength and eliminate vibration. Impellers are keyed to a heat treated, forged steel shaft. Labyrinth packing is employed to prevent leakage between impeller and casing. Bearings are ring oiled and both bearings and their housings are parted horizontally.

The use of flexible couplings between blower and driving unit is standard practice on all I-R Turbo Blowers. Machines are all of the closed intake type. The intake openings is at the bottom and discharge at the top.

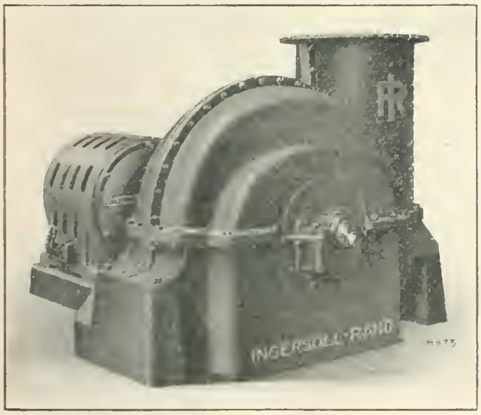


FIG. 1.

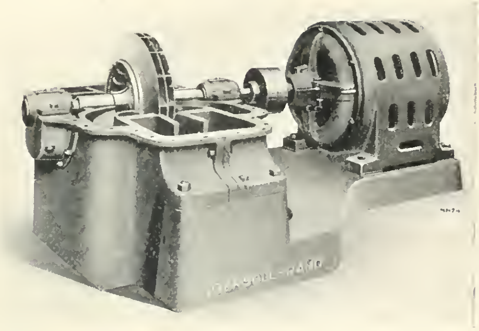


FIG. 2.

The flow of air from this type of blower is absolutely uniform, avoiding all pulsations, which makes it especially desirable for foundry work. The manufacturer emphasizes the fact that there are no rubbing surfaces in the I-R Turbo Blower and points out that this precludes the necessity for adjustment to take up wear and minimizes the cost of maintenance. It is to be noted that the only lubrication necessary is that of the bearings, all other parts working without friction. Fig. 1 shows a low pressure turbo blower complete and Fig. 2, taken from the opposite corner, shows the same machine with the upper portion of the casing removed.

RAPID SPREAD OF THE PNEUMATIC TIE TAMPER

Pneumatic tie-tamping machines have reached a high state of development in the two years they have been in commercial use. They are now a standard track tool in the maintenance-of-way department of many steam and electric railways. Hand tamping did well enough in the past, but in this day of labor shortage the semi-mechanical method is more desirable. As an indication of the status of this method, the Pennsylvania Lines East alone have 150 [216 by the latest count. Ed. C. A. M.] of these tampers in service, according to the Ingersoll-Rand Co.

Air tampers can be operated from pneumatic signals or other air-power lines. Pneumatic signal lines are usually at 110-lb. pressure, but the switches will operate satisfactory on 60 lb., allowing ample leeway for a drop in presure from any cause whatever. The Pennsylvania operates tampers on these air lines and experiences no difficulty from lowered pressure, although as many as four tampers have been used at one point. Where air is not available, a self-propelled compressor-car is provided. This is built in two sizes—for two tampers and four tampers respectively. The power is furnished by a gasoline engine. The maximum speed loaded is 15 mi. per hr. On electric street and interurban railways power usually is obtained by the use of a motor-driven compressor, mounted for coupling to a work-car or a regular street-car. Whenever a large number of tamping machines are required, as in laying new track, a standard steam or electric-driven compressor can be installed in a work-car.

Portable compressor plants of two- or four-tool capacity cost from $2,000 to $2,500 each, making a rather large investment for only one class of work. These power plants, however, can also supply air for such purposes as boring spike-holes, tightening bolts, drilling and reaming bolt-holes and bond-holes in rails, driving rivets and chipping metal in steel-culvert, bridge and cattle-guard work, tamping earth around culverts, driving plug drills in rock excavation, operating pumps, hoists, jacks, concrete mixers, etc.

Tamping bars for different thicknesses of face are provided for tamping the various kinds of ballast. The thickest tamping bar is that used for cinders, earth, gravel, sand or chat. The thinnest head is for rock ballast of 2-in. mesh or larger. The bars in each case are 18 in. long, with a face 3 in. wide.

The "Imperial" tie tamper weighs 37½ lb. Its best operating pressure is 65 to 75 lb., its consumption at 70 lb. being 16 cu. ft. of free air per minute. The two-tool "Imperial" gasoline-engine-driven compressor-car weighs 2,000 lb. (without hose or tampers). It is 9 ft. 9 in. by 5 ft. 7 in. in plan by 5 ft. 6 in. high and will carry 12 men with equipment. The air capacity is 45 cu. ft. of free-air piston displacement per minute. The gasoline consumption at full load is 1¼ gal. per hr. The tank capacity is 15 gal.—*Eng. News.*

LEYNER DRILL SHARPENER OPERATED BY A CHINAMAN.

THE WORLD'S MECHANICAL KINSHIP

No matter how the world's workers may differ as to race, language, habit, location or environment they can all appreciate the modern devices for mechanical accomplishment and are adopting them the world over. The little half-tone above reproduces a photo of a Leyner rock drill sharpener operated by a Chinaman at the Tul Mi Chung Mine, Korea, Mr. A. Alec. Jones, mine surveyor, who sends the photo, gives no further information except the somewhat superfluous item that the sharpener gives the mine superintendent entire satisfaction.

NOTES

In using heavy and extra heavy iron or steel piping for the great pressures sometimes called for in compressed air practice it should be remembered that the outside diameters of such piping and the threading of the fittings do not change, the extra thickness being secured by the reduction of the internal diameter, so that to get a sufficient area for the flow of the air it is sometimes necessary to use the next larger nominal size of pipe.

It is claimed that the falling off in efficiency shown in the afternoon by laboring men is due in large measure to eating a cold lunch at noon. For this reason some contractors are beginning to experiment with containers designed to keep hot the lunches and drinks of their men.

A lately developed use of compressed air is for the cleaning of furs previous to their storage for the summer. A nozzle is used with a very minute opening, preferably a thin elongated slit. This is run carefully over the surface of the fur to dislodge dust, eggs, etc., which it does effectively and without injury.

It is computed that the horse-power of gasoline internal-combustion engines in the United States is more than twice that of all engines in the country driven by steam. The former include 2,225,000 automobiles, 300,000 motorboats, 45,000 motor-trucks, and 30,000 farm-tractor engines.

James T. Myers, of Callam Bay, Wash., blasted a ditch 3,270 feet long and averaging 2 feet, 10 inches deep, with dynamite in 17 days without help, reclaiming a number of acres of land. It carries off the water formerly flooding the land and has required no shoveling out of caved sides of the ditch since it went into operation.

An important discovery has been made along the lines of scientific progress in Sheffield, in the introduction of stainless steel. As this material will not stain or rust, no matter how it is used, it is particularly adapted for knife blades, which retain their original bright surface. That knives made of this steel will have a large sale no one now questions, but the development of this new branch of the steel industry has been seriously handicapped by the war.

Nails driven in wood that is exposed to alternate wetting and drying are liable in time to start to work out. The wetting swells the wood and increases its dimensions across the grain, and as the nail is inelastic it is moved, a space forming at the point equal to the amount of swelling of the wood. When the timber dries the nail does not return to its original place, and if tapered it tends to move outward each time that wood is wet and dried. It is for this reason that wood structures bolted together and exposed to the weather require screwing up at intervals.

It has been pointed out (Bull. sci. pharm. 1914, 463) that tincture of iodine is incompatible with mercury chloride. Now that iodine is used so widely as a first aid disinfectant for wounds, it is important to remember that the use of mercury perchloride dressings applied afterwards is dangerous, owing to the formation of mercury iodide, which is strongly irritating. Iodine and mercury dressings should never be used together. In cases where mercury iodide has been formed the best method of removing it is to wash the wound with 10 per cent. solution of potassium iodide.

With the increasing use of acetylene gas the risks of its corrosive effect on pipes and metal containers should be better known. Tests have shown that most acetylene, as generated, attacked zinc, lead, brass and nickel to a slight extent; iron was affected six to seven times as much; but copper suffered more than any other metal tested. Copper was quickly changed into a soft, porous black mass. Tin, aluminum, bronze, german silver and solder were practically unaffected. Thus it would appear that copper and brass or other copper alloys should not be used as piping for acetylene-gas supplies, and that iron should be well tinned rather than galvanized or nickel plated.

A rare ceremony took place recently at Wirksworth, Derbyshire, England, when the grand jury of the Ancient Great Barmote Court of the Soke and Wapentake of Wirksworth was summoned to give away the lead mine known as the Dinah, in the Liberty of Wirksworth, to three claimants, one of whom was a Manchester man. The award was strictly in accordance with the ancient lead mining laws of the Peak, which prescribe that when a mineowner fails to work his mine to the satisfaction of the Barmaster (an official of the Royal Duchy of Lancaster), any person may hand in a claim for the property. Formal notices are then posted near the mine for three weeks, and if the mine is not then being worked satisfactorily the award takes place to the new claimant.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

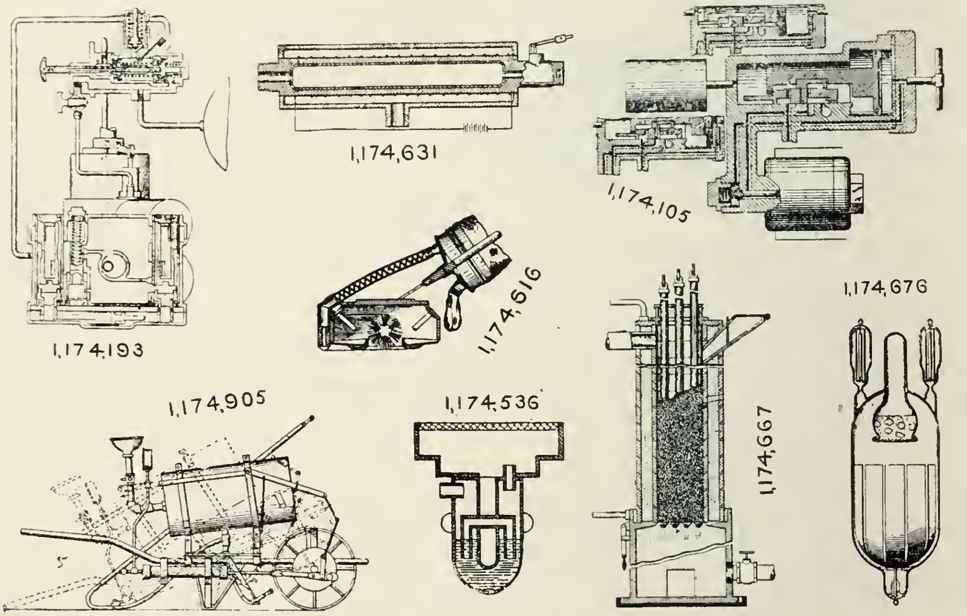
MARCH 7.

1,174,105-6. ELECTROPNEUMATIC BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,174,193. PNEUMATIC STARTING MECHANISM FOR INTERNAL-COMBUSTION ENGINES. GREGORY J. SPOHRER, East Orange, N. J.

1,174,536. APPARATUS FOR INDICATING CHANGES IN ATMOSPHERIC PRESSURE. MARTIN ALBRECHT, Frankfort-on-the-Main, Germany.

1,174,616. VACUUM CLEANING APPARATUS. JULIUS SCHIRRA, Pittsburgh, Pa.


1,174,193
1,174,631
1,174,105
1,174,616
1,174,905
1,174,536
1,174,667
1,174,676

PNEUMATIC PATENTS MARCH 7.

1,174,631. APPARATUS FOR SEPARATING GASES. WALTER O. SNELLING, Pittsburgh, Pa.

1,174,667-8. PROCESS OF FIXING NITROGEN AND ELECTRIC FURNACE FOR EFFECTING THE SAME. JOHN E. BUCHER, Coventry, R. I.

1,174,676. VACUUM VALVE-TUBE. EUGENE W. CALDWELL, New York, N. Y.

1,174,807. PNEUMATIC ACTION. WILLIAM G. BETZ, Buffalo, N. Y.

1,174,905. SPRAYING-MACHINE. AUGUST C. SEEGER, East St. Louis, Ill.

1,174,919. GLASS-BLOWING APPARATUS. ALBERT C. WILCOX, Wheeling, W. Va.

MARCH 14.

1,175,006. APPARATUS FOR ADMINISTERING LIQUID ANAESTHETICS. FREDERIC MONTGOMERY, New York, N. Y.

1,175,050. SPEED INDICATOR AND RECORDER. LONGFELLOW J. DAFT, Issaquah, Wash.

In a speed indicator and recorder, a revoluble shaft, a pump operable by the revolution of the shaft to compress air, a tank to receive the air when compressed, a revoluble indicator disk carrier, a cylinder, a piston in said cylinder, a pencil carrying arm operatively connected with said piston, a spring normally urging said piston in one direction, and a pipe connecting the tank and cylinder whereby to force said piston against the action of said spring.

1,175,053. ELECTROPNEUMATIC BRAKE. JAMES S. DOYLE, Mount Vernon, N. Y.

1,175,097. FLUID-OPERATED GEAR-SHIFTING DEVICE. FRANK L. WALTER, Dayton, Ohio.

1,175,484. APPARATUS FOR COMPRESSING AIR OR OTHER GAS. FREDERICK WILFRID SCOTT STOKES, London, England.

1. In apparatus for compressing air or other gas the combination of a compressor cylinder having an inlet through which both high and low pressure gases enter, a low pressure suction valve, a valve for the high pressure gas and electro-magnetic means for keeping such high pressure gas valve closed during the required period.

1,175,620. AIR-BRAKE SYSTEM. FRANK H. DUKESMITH, Pittsburgh, Pa.

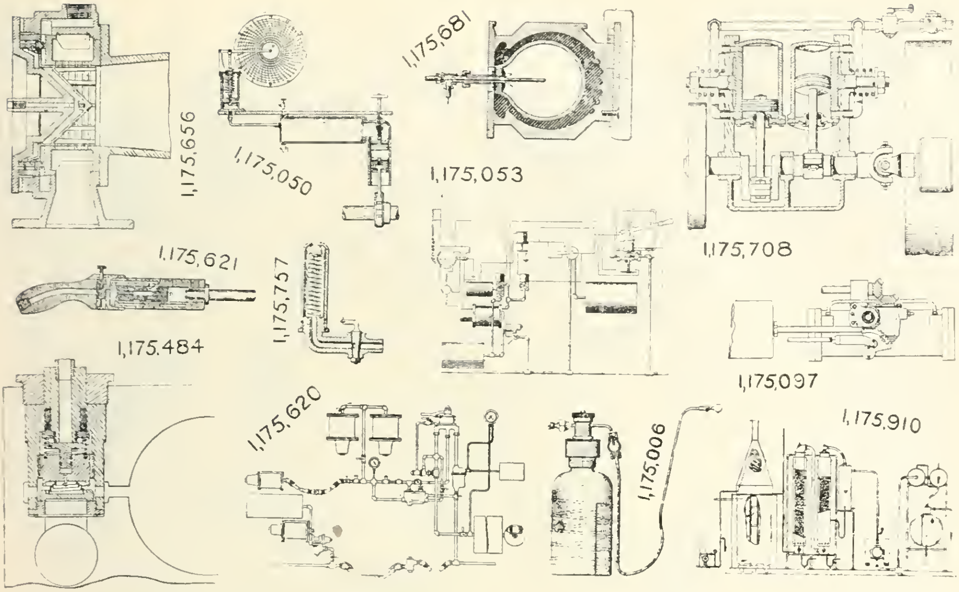
1,175,621. IMPACT-TOOL. CARL EKBERG, Everett, Wash.

1,175,656. SOUND-PRODUCING DEVICE FOR FOG-SIGNALING, POSITION - LOCATING, OR THE LIKE. JOHN PELL NORTHEY, Toronto, Canada.

1,175,681. PNEUMATIC-TIRE APPARATUS. GEORGE ELLINWOOD BATCHELLER, New York, N. Y.

1,175,693. PROCESS OF PRODUCING TUNGSTEN. CARL BOSCH and ALWIN MITTASCH, Ludwigshafen-on-the-Rhine, Germany.

1. The process of producing tungsten which consists in reducing a pure tungsten compound with hydrogen at a moderate temperature and



Pneumatic Patents March 14.

under pressure above that of ten atmospheres.

1,175,708. AIR-STARTER FOR INTERNAL-COMBUSTION ENGINES. Fred E. Cline, San Diego, Cal.

1,175,745. DRILLING APPARATUS. George H. Gilman, Claremont, N. H.

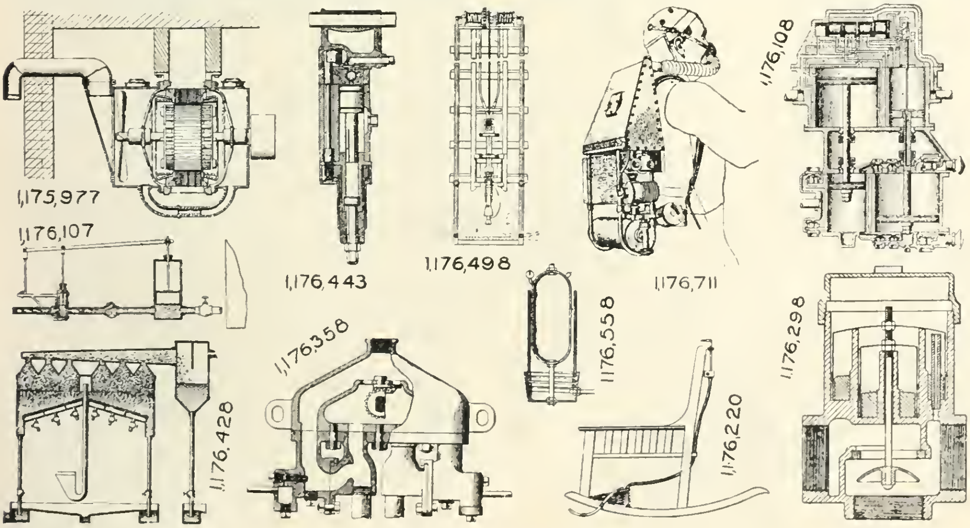
1,175,757. AUTOMATIC AIR-SUPPLY DEVICE. Byron D. Hathway, Woolstock, Iowa.

1,175,876. METHOD OF TREATING MILK. George Sinclair, St. Paul, Minn.

2. The process of pasteurizing milk consisting in gradually heating to approximately 150 degrees F., passing sterile air over, about, and up through the milk during said heating operation, cooling and incubating such milk, and finally flashing to near the death point of the *B. acidi lacti* contained therein.

1,175,910. PROCESS OF MAKING MOTOR-FUEL. William Augustus Hall, New York, N. Y.

4. Process of producing from mineral oil, liquid fuel suitable for use in automobile engines, consisting in cracking the oil under pressure to produce gases and vapors, expanding such gases and vapors, then subjecting such gases and vapors to sudden increase of pressure sufficient in amount to produce an endothermic reaction therein, while the gases are in a heated state, condensing the products so formed and clarifying the product.



Pneumatic Patents March 21.

MARCH 21.

1,175,977. COOLING SYSTEM FOR ELECTRIC MOTORS. John William Nolan, Pawtucket, R. I.

1,175,979. PRESSURE-GAGE. John F. O'Connor, Chicago, Ill.

1,176,107. AUTOMATIC DEVICE FOR CUTTING OFF THE FLOW OF AIR THROUGH OIL-PIPES. Thomas A. Tucker, Burkburnett, Tex.

1,176,108-9. FLUID-COMPRESSOR. Walter V. Turner, Edgewood, Pa.

1,176,220. AUTOMATIC CHAIR-BLOWER. Antoni Kaczmaszky, Piper, Ala.

1,176,293. GAS-PRESSURE REGULATOR. Robert L. Hibbard, Sewickley, Pa.

1,176,358. TRACK-SANDING DEVICE. John Gapp, Scranton, Pa.

1,176,428. FLOTATION SEPARATORY APPARATUS AND PROCESS. John M. Callow, Salt Lake City, Utah.

1. In flotation separatory apparatus, the combination with a tank adapted to contain comminuted ore and water and a frothable agent, said tank having a bottom restrictedly open to the atmosphere, and means for producing a suction in said tank to draw air through said bottom to generate bubbles and to destroy said bubbles and remove the mineral particles floated thereby.

1,176,443. PERCUSSIVE TOOL. Charles H. Haeseler, Philadelphia, Pa.

1,176,498. GLASS-MAKING PROCESS AND APPARATUS. Lincoln A. Thornburg, Arnoid, Pa.

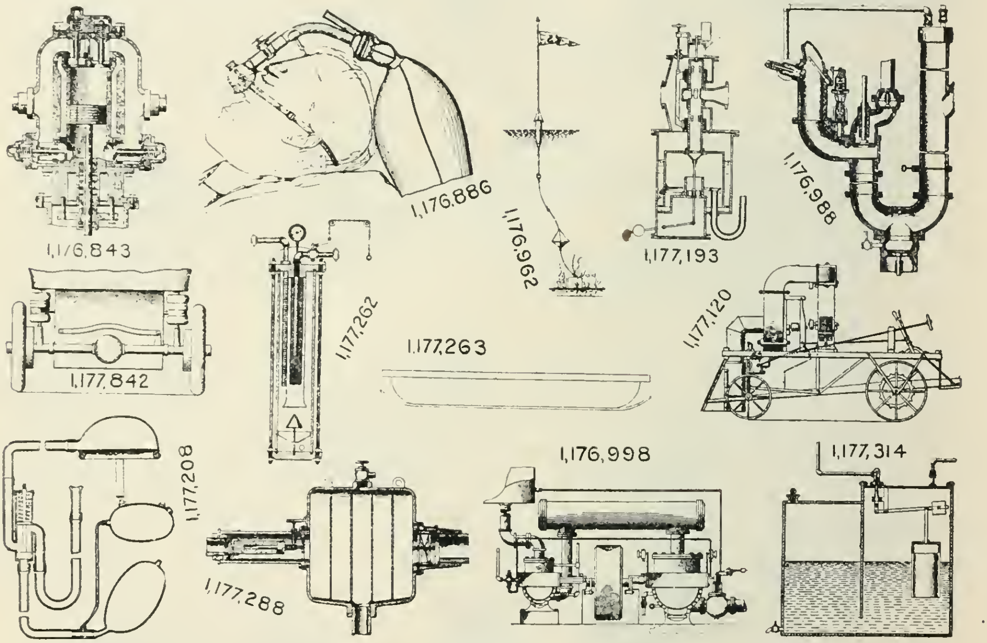
1,176,558. AIR-COOLING APPARATUS. Joseph Hollenburger, Shiner, Tex.

1,176,708. ROCK-DRILL. Albert Ball and Thomas Officer, Claremont, N. H.

1,176,711. MINE BREATHING APPARATUS. William E. Gibbs, New York, N. Y.

MARCH 28.

1,176,843. COMPRESSOR. John B. Lukomski and Anthony Lukomski, Detroit, Mich.



Pneumatic Patents March 28.

1,176,886. INHALER. George Ermold, New York, N. Y.

1,176,962. WHISTLE-BUOY. William A. Heyer, Milwaukee, Wis.

1,176,988. PUMP. Charles H. Rittenhouse and William E. Hallett, Phoenix, Ariz.

1. In apparatus of the class described, the combination of a play pipe, an explosion chamber, an intake for the play pipe, means for supplying air to said chamber during each outstroke of the water in the play pipe, means for injecting fuel into said chamber whereby an explosive mixture is formed therein, means for igniting said mixture, and means whereby the burnt gases are exhausted from said chamber on each instroke.

1,176,998. AUTOMATIC REGULATOR FOR AIR-COMPRESSORS. Arthur Ward and Thomas Franklin Pence, Webb City, Mo.

1,177,120. COTTON-PICKING MACHINE. Thomas Manners, Waterloo, Okla.

1,177,142. PNEUMATIC-CUSHION STRUCTURE. Herbert F. Rudd, Chicago, Ill.

1,177,193. DEVICE FOR MEASURING AND FOR REGULATING THE FLOW OF FLUIDS—LIQUID OR GASEOUS. Hendrick Mathys Liese, Hamburg, Germany.

1,177,208. PULMOTOR. Juriah Harris Pierpont, Pensacola, Fla.

1,177,262. AIR-FILTER. Lewis Grant O'Donnell, Coscob, Conn.

1,177,263. PNEUMATIC RUNNER FOR VEHICLE-SLEDS. Jocelyn Emile Ollivier, St. Gervais, France.

1. A runner for vehicle-sleds comprising a frame, a flexible runner blade, and an intermediate elastic member adapted to be inflated with gas and to exert a uniform pressure over the entire bearing surface of the runner blade.

1,177,288. AUTOMATIC AIR-EJECTING APPARATUS FOR HEATING SYSTEMS. Edward R. Teller, Jr., Westwood, N. J.

1,177,314. GAS-PRESSURE REGULATOR. Bernhardt Mathias Gattermeir, California, Mo.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XXI JUNE, 1916 No. 6

SPEED AND ECONOMY OF THE DEEP HOLE DRILL WAGON

BY CHARLES A. HIRSCHBERG.

Sufficient time has elapsed since the introduction of the first deep-hole drilling rig about five years ago to determine definitely the fitness of such apparatus for use in rock excavation. An analysis of the uses to which it has been successfully put, and the results accomplished, demonstrate conclusively that such work as the excavation of rock in deep crushed-rock quarries, extensive railroad cuts and canal work is the especial field of the deep-hole drilling rig.

The main problem presented by such work —the rapid breaking up of large areas of rock —is such that the ordinary type of drilling machine mounted on a tripod will not do, for, if the latter is light enough to permit of easy and quick mobility, it is not powerful enough to drill the depth and diameter of holes necessary to rapid and economical excavation in this class of work. If, on the other hand, heavy enough tripod drills are employed, they lack quick mobility, and the time consumed and difficulties encountered in this respect make the operation of resetting for each hole slow and expensive.

The deep-hole rig, with its means for traction and ability to drill a number of holes at one setting, at once permits the employment of powerful drilling machines and eliminates a large portion of the dead time of resetting.

An idea of the economy which obtains, in labor alone, with these drilling rigs may be had when it is understood that they will drill from 150 to 250 ft. of large diameter hole per day with a crew of three men. With the tripod method the footage rarely exceeds 70 ft., and is more often as low as 60 ft. It would, therefore, require from three to four tripod drills to accomplish as much work, or from three to four times the labor and, of course, a proportionately greater amount of power.

Large diameter holes permit heavy powder loading, making springing unnecessary. This again means a material saving, as the springing of holes requires extra powder, extra labor, and in a great many cases results in the partial loss of holes, due to their becoming filled with muck in the springing process.

The progression of drilling with a deep-hole rig is shown in Fig. 1. The drill frame is swung at right angles to the line of progress, the jack-screw set, and a hole drilled. The drill is then raised and swung parallel with the line of progress and another hole drilled. Again the drill is raised and swung

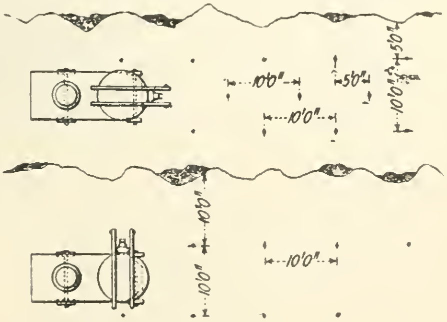


FIG. 1.

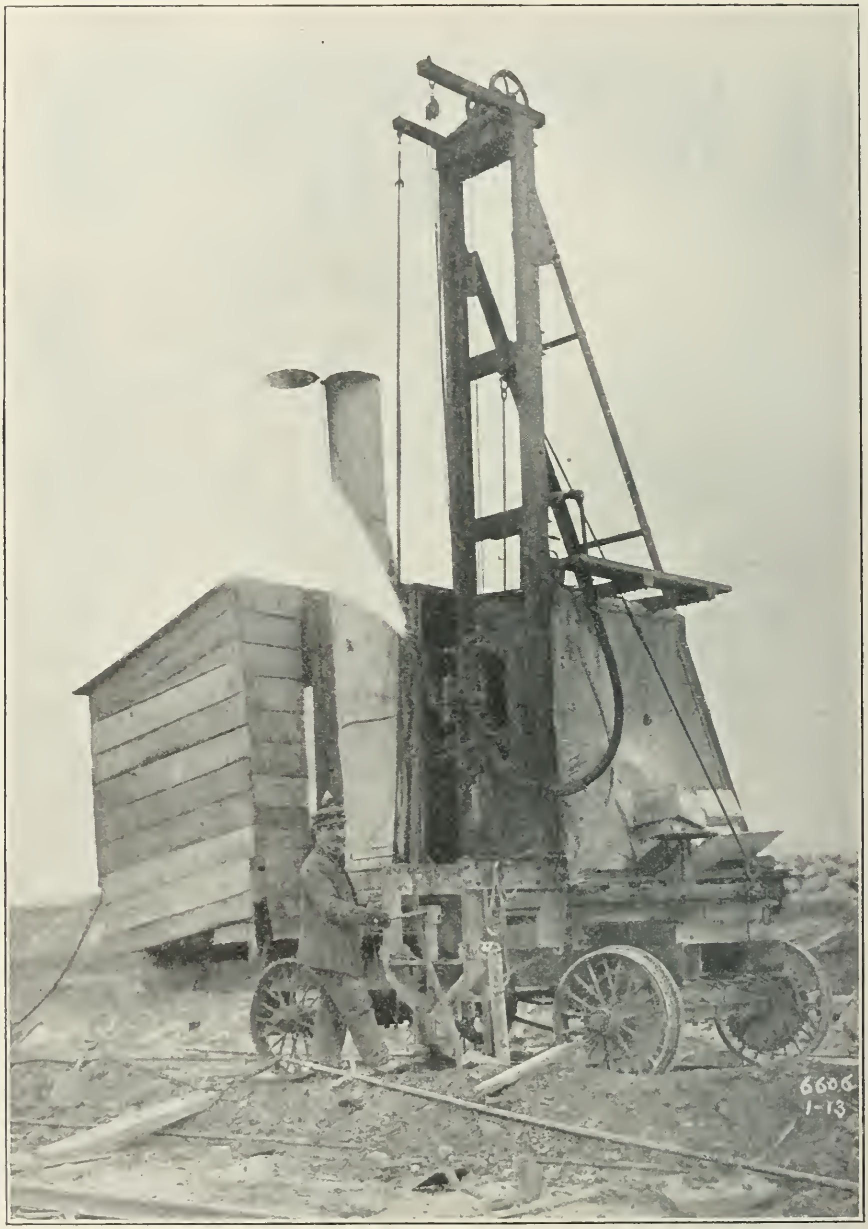


FIG. 2.

at right angles, to the opposite side, and a third hole drilled.

In this manner three holes are put down from each position of the machine, two on a line at right angles, the distance apart depending upon the sweep of the drill frame, and one-half this distance in advance of or behind the others, and on a line midway between them. The drill wagon is then moved forward or back the proper distance and the operations repeated. When the required length has been covered, the drill is moved over and another triple row of holes, paralleling the first, put down, and so on continuously. Blasting is generally begun after sufficient ground has been drilled, while drilling progresses further on.

For successful drilling of deep holes it is necessary to provide a means for freeing the hole of cuttings during drilling operations. For this purpose a water jet is provided which is placed in the hole alongside the drill steel. A pipe about ½ in. in diameter is suspended from the top of the derrick, which can be raised or lowered to suit the position of the drill bit. This pipe is connected by means of rubber hose with either a pump mounted on the top of the drill wagon turntable, the pump suction being connected to any convenient water supply, or to a water pressure line. The amount of water fed into the hole is under the control of the operator.

In operating, the drill runner stands on the turntable, where he has control over the operation of the drill. The helper tends to the water jet and steel, lowering the pipe with the steel. As soon as a hole is finished a wooden plug is dropped into it, to keep it clear until ready for loading.

TYPICAL INSTALLATIONS.

A few typical installations and records of accomplishment are described in the following.

TABLE 1—PROGRESS WITH 15-FOOT FEED WAGON DRILLS ON CALUMET SAG CHANNEL OF CHICAGO DRAINAGE CANAL

	No. of 10-hour shifts	No. of Holes	Total Lineal Feet	Av. per shift
July, 1912	9	173	1,453	161
August, 1912	31	563	4,947	160
September, 1912....	50	1,051	8,512	170
October, 1912......	54	1,052	8,968	166
November, 1912....	49	537	6,197	126
December, 1912. ..	45	442	6,184	137
January, 1913......	47	750	6,809	145
February, 1913....	35	699	5,783	165
March, 1913 (2d lift)	38	643	4,909	129
April, 1913	52	796	10,464	201
May, 1913.........	54	897	10,820	200
June, 1913.........	54.9	1,016	13,287	244
July, 1913.........	50	838	10,679	213
August, 1913......	49.6	980	11,179	225
September, 1913...	52	984	12,170	234
October, 1913......	58.4	1,177	14,293	245
November, 1913....	50	739	10,679	214
December, 1913....	46.8	635	9,058	193
January, 1914......	36.9	533	7,304	200
February, 1914....	...	...	......	...
March, 1914.......	16	219	2,974	185
April, 1914.........	50.5	910	11,629	230
May, 1914.........	52	1,040	12,434	239
June, 1914.........	50.4	973	11,245	223
July, 1914.........	54.8	1,044	12,411	226
August, 1914......	84	1,445	18,219	217
September, 1914....	37	676	7,117	192
November, 1914....	..	...	.....	...
December, 1914....	12	12	2,565	211
March, 1915.......	12.6	173	2,422	192
April, 1915........	20.7	343	4,768	230

Average feet per drill per 10-hour day for entire 2½ years = 199.1.

Sixteen deep hole drill wagons were used on the Champlain Barge Canal, working ahead of a Marion steam shovel. The holes drilled averaged 12 ft. in depth and 4 in. in diameter. They were spaced on 5 and 10-ft. centers. Each hole was drilled with one length of steel. The average drill hole footage per shift, for each drilling rig was between 160 and 200 ft.

On the Calumet Sag Channel of the Chicago Drainage Canal the contractors employed two 15-ft. feed steam wagon drills, Fig. 2. The

TABLE 2—PROGRESS WITH 20-FOOT FEED WAGON DRILLS

July 11 to Dec., 1914, and Feb. 22 to Aug. 8, 1915.

	Total lin. feet	Av. per shift	Max. shift	Min. shift
1914				
Drill No. 1—130 day shifts (10 hr.)	27,739	213.4	425 ft.	68 ft.
Drill No. 1—49 night shifts (10 hr.)	7,347	149.9	264 ft.	17 ft.
Drill No. 2—112 day shifts (10 hr.)	28,174	251.5	425 ft.	85 ft.
Drill No. 2—30 night shifts (10 hr.)	4,129	137.6	272 ft.	34 ft.
1915				
Drill No. 1—142 day shifts (10 hr.)	37,658	265.1	475 ft.	64 ft.
Drill No. 2—139 day shifts (10 hr.)	38,335	275.8	510 ft.	51 ft.

rock encountered in this work was hard Lemont limestone with flint strata. The excavation was made in three lifts, holes averaging 11 ft. 9 in. in depth and 3¼ in. in diameter. Two-inch hexagonal steel with cross-bits was used. The first lift was very much broken; the second and third lifts were solid. Table 1 shows the drilling progress made by the contractors under these conditions.

Another contractor secured the following results, Table 2, with two 20-ft. feed, steam wagon drills. The rock on this contract was hard Lemont limestone with flinty strata and containing horizontal seams filled with a cementaceous mud. In many places the rock was very shattered. The holes averaged 17 ft. in depth and 3½ in. in diameter. Two-inch hexagonal steel with cross-bits was used.

The wagon drill, Fig. 3, employed in the quarry at Valhalla, N. Y., of H. S. Kerbaugh, Inc., contractors for the Kensico dam of the Catskill Aqueduct, was of the electric-air type, taking current from wires strung in the quarry. The holes drilled averaged 50 ft. in depth, bottoming 3 in. in diameter, and 30 ft., bottoming 4½ in. in diameter. Under test conditions 104 ft. of hole was drilled per shift.

It has been estimated that the cost per foot, based upon power and labor charges alone, on an average day's work of 50 ft. of hole (which was very conservative) approximated 14 cents per foot. The extraordinary feature, however, was the power cost. This sometimes ran as low as 30 cents per day and never exceeded 70 cents. Fig. 4 shows a series of holes drilled and prepared for blasting in the Kensico quarry. It is surprising to note that the work was done by this type of rig on ground with a decided grade and irregular in contour.

Contractors on the United States Govern-

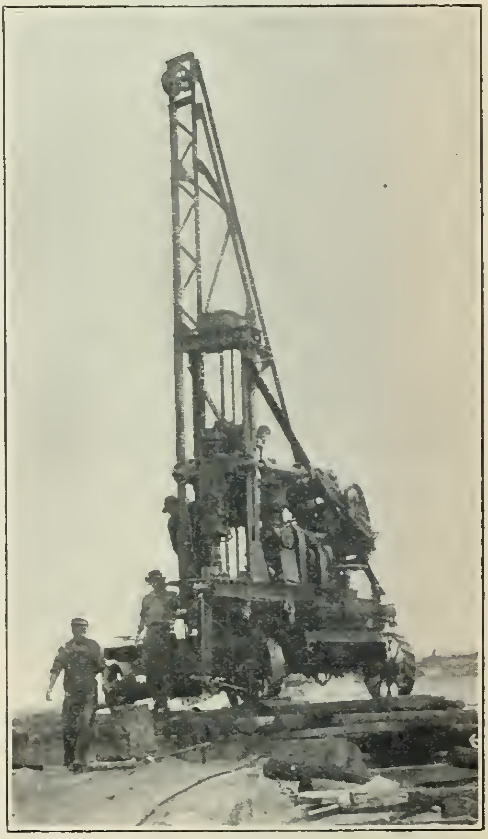


FIG. 3.

FIG. 4.

ment Locks at Sault Ste Marie, Mich., employed four 18-ft. steam wagon drills. The rock drilled was Potsdam sandstone, considerably broken and containing many mud seams. Holes varied in depth from 18 to 27 ft. All holes bottomed 4¼ to 4½ in. in diameter. Cuttings would not mix satisfactorily with water and they were therefore drilled dry and a ⅜-in. jet of air at 100 lb. pressure was used to clean the holes.

Prior to the installation of these four wagon drills, fifty tripod drills were used, but could not keep ahead of the steam shovels. The four wagon drills which displaced them were 1,000 ft. ahead of the shovels within three months after installation.

Table 3 gives the record of each traction drill working three shifts during July, 1913. Each drill ran three eight-hour shifts except where indicated.

A drill wagon was put to a rather novel use by Smith & McCormick, contractors, several years ago in repairing a heavy concrete bridge or arch over a tunnel of the Erie Railroad at Bergen Hill, N. J. Holes were drilled varying in depth from not less than 40 to more than 50 ft. in the concrete structure, which was of heterogeneous nature, comprising rough stones, more or less iron and other rubbish compacted with occasional loose or unfilled spaces, and, as a result, presented considerable drilling difficulties.

The purpose of the holes was to permit of pouring cement grouting to solidify the concrete mass, which had developed numerous cracks after completion.

FIVE CHURN DRILLS SUPERSEDED.

During last year the Dewey Portland Cement Company of Dewey, Okla., installed a steam wagon drill for work in its cement quarry. Up to that time this drilling had been done with five churn drills, which were displaced.

The first row of holes was drilled within 10 ft. of the quarry face, this distance being sometimes increased to 15 ft. A second row of holes was drilled 10 ft. back of the first row. Holes were spaced 10 ft. apart in the rows. All holes were drilled with a single steel to a depth of 20 ft., bottoming 3½ in. An average drilling progress of ten and sometimes eleven holes per day obtained. In blasting, from thirty to fifty holes were exploded at one time.

The drilling crew consisted of three men receiving the following wages: Main operator $3 and two helpers $2 each per ten-hour day. No accurate record was kept of the coal consumption, but this was estimated to be 1,300 lb. per day, costing $3 per ton

TABLE 3—ROCK DRILLING AT SAULT STE. MARIE

Date	No. 1	No. 2	No. 3	No. 4
1	194	136	120	272
2	254	85	200	306
3	194	170	200	234
7	207	100	126	252
8	253	176	136	270
9	209	256	187	288
10	240	†68	143	198
11	*144	*153	*85	108
12	†25	...	156	..
14	150	194	270	*119
15	100	216	154	234
16	†25	180	126	171
17	*125	216	221	304
18	*100	306	264	313
19	*125	270	*119	213
21	*85	198	187	304
22	*156	*108	*95	144
23	153	162	160	272
24	*136	180	172	240
25	121	198	†36	240
26	*106	*119	198	352
28	*228	†102	126	206
29	260	272	198	255
30	260	*85	220	204
31	*120	*187	†40	*152
Total	3,990	4,136	3,939	5.652
Average per shift	65.4	62.6	58	79.7

---

*Two shifts.

†One shift.

delivered. Based on the foregoing costs and including the items of maintenance and depreciation, the cost per foot of hole drilled was 7½ cents per foot. This cost compares with 25 cents per foot for the churn drills formerly used.

It was further found that, owing to the ability to place the holes better, blockholing was reduced about 50 per cent.

A PNEUMATIC INCIDENT

A country girl from the lower part of South Carolina—they call them Crackers down there—went to Savannah to pay her first visit to a dentist. The dentist found a jaw tooth badly in need of his services. He drilled away the decayed spots, and then, to clear the cavity of small particles, brought into use a small hand bulb. As the first gush through the blowpipe struck her mouth, the patient flinched.

"Can you feel that air?" inquired the dentist.

The young woman gazed up at him, puzzled. "That air what?" she inquired simply.

—*Saturday Evening Post.*

LIGHTING THE PANAMA CANAL

The United States is largely indebted to the efforts of Swedish engineers for an economical means of lighting the Panama Canal. In Sweden the reefs and narrow inlets are a menace to skippers and fishermen, but the expense of engaging lighthouse keepers and providing them with the means of livelihood would be so great that many dangerous points had necessarily to be left unguarded. That resulted in Gustaf Dalen creating the self-tending lamp, which affords a practical and economical means of light. From that was finally evolved the Aga gas accumulator, which contains 100 times its own volume of gas, and is, at the same time, safe and nonexplosive. It can be fixed to burn for a year or even a longer time without personal attention. The Aga flashlight apparatus also makes it possible to give distinctive characteristics to lights, of any desired duration or combination, while another marvel of this economical device is the sunvalve, which extinguishes the light during the day.

HAND DRILLS IN STRUCTURAL WORK

BY CHARLES C. PHELPS.

A laborer with a chisel or a pipe-bit and hammer can drill holes of small diameter in concrete at an average rate of about 1 ft. per hr. In brick the rate of cutting is faster. It is thus apparent that the hand method is almost prohibitive in cost under many circumstances, and would be out of the question if a large number of holes had to be cut in a short time. Various types of rock drills are well adapted to work of this character and, in fact, have been so applied with marked economies in several instances.

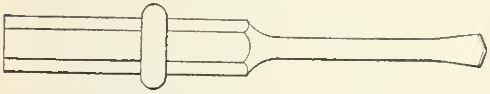


FIG. 1.

A notable job of this nature was the drilling of approximately 9,500 window-bolt holes at the reconstructed Edison Phonograph Works, West Orange, N. J., following the disastrous fire in December, 1914. Each bay required 17 expansion bolts to hold the fireproof steel window frame. It was necessary to drill a hole 3½ in. deep by ¾ in. in diameter in the concrete walls, to accommodate each bolt. These holes necessitated both horizontal and vertical drilling. For the purpose a Jackhamer with a special bit of hexagon steel (Fig 1) was employed. Two men handled the drill, one holding the drill itself and the other guiding the bit (Fig. 2). They averaged 500 holes per day, their work including the frequent moving of scaffold and the changing of air connections. This figure reduces to 15 or 16 ft. of hole drilled per hr. The Jackhamer was used for drilling both horizontal and vertical holes, but many of the up-holes were drilled with a butterfly stope drill (Fig. 3). Both of these drills were employed also for drilling holes preparatory to removing some of the concrete construction.

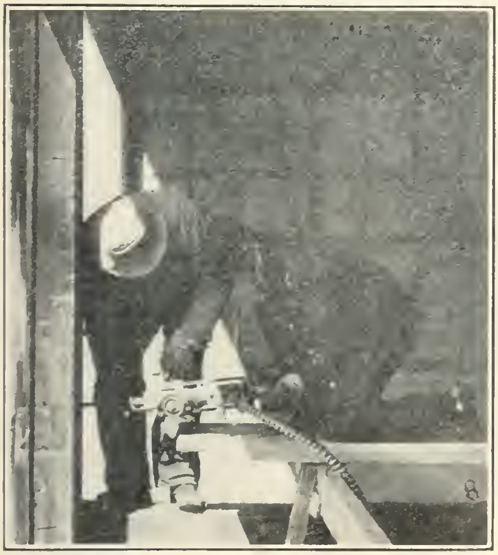


FIG. 2.

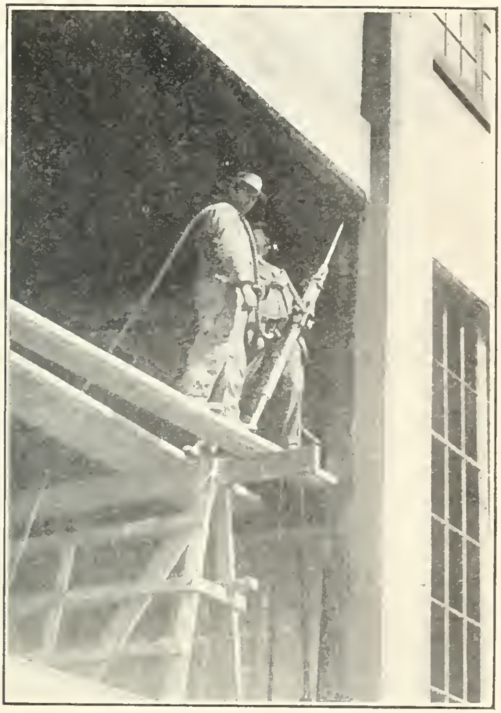


FIG. 3.

This is a good illustration of a large number of small anchor-bolt holes drilled economically. An example of a number of large anchor-bolt holes bored at low cost is found in the Quebec Bridge. There were 176 of these holes, 5 ft. deep by 4½ in. in diameter, drilled in granite masonry with a Calyx chilled-shot core-drill.

MISCELLANEOUS USES FOR HAND HAMMER DRILLS.

Drilling holes in machinery foundations for hold-down bolts; in floors for railings; in walls or ceilings for pipe, wire, shafting, conduit brackets or hangers, and lighting fixtures; and in walls of buildings for fire-escape brackets, are other uses to which pneumatic drills and hammers have been applied with advantage. They are equally valuable for such other applications as cutting openings in floors or walls for windows and doors, shafting, belting, pipes, wires, etc., and for cutting channels in concrete floors or ceilings.

A Jackhamer has seen considerable service along these lines at the Government Printing Office in Washington. The floor construction there is of concrete and brick arches, and the ceilings are constructed of concrete tiles. The space between floor and ceiling is used for piping, electric wires, etc., and it is often necessary to cut holes in floor or ceiling when installing machinery or lights, the Jackhamer being employed for the purpose. The drill takes its air from the regular 50-lb. air lines in the Printing Office. When cutting concrete flooring, one man can drill a hole through the floor (10 to 10½ in. thick) in 2½ min. Ladders or staging are required for ceiling work, and for such work two men handle the drill. The automatically rotated type of drill is especially well adapted for use where footing is insecure or elbow room restricted, as on ladders, falsework or swinging scaffolds.

In another case where hanger holes were drilled in rock it formerly required a whole day for two men with hammer and steel to drill 9 or 10 holes, each 4 to 6 in. in depth, whereas now one man drills the same number of holes in 10 to 15 minutes with a hand hammer drill.

Hundreds of elevated-railway column foundations are being removed in New York with the aid of Jackhamers. These brick footings are located above the new subway in the lower part of the city. They will be replaced by concrete foundations. These footings are in the shape of truncated pyramids 8 or more feet high and about 4 ft. square on top. Fig. 4 shows three of these foundations partly uncovered before removal. After the elevated structure has been supported on falsework, holes are drilled from 12 to 20 in. in depth. The brick is then broken out with sledge-and-wedge.

One of the earlier applications of plug drills for work of this nature was for cutting out concrete and brickwork at the New York end of the Brooklyn Bridge, to make room for a subway terminal. Hammer drills of the non-rotating butterfly type were used, as the more suitable automatically rotated drills had not been developed at that time. The work necessitated cutting through, first, an 18-in. layer of fine cement concrete; next, about 3 ft. of rough gravel concrete; and finally the brick supporting arches or vaulting. The material was cut away in layers or benches—first, the top layer, which, though hard, was fairly uniform and good cutting; next, the rough concrete, which was very difficult to cut; and then the brick, which was comparatively easy cutting. In one instance it was found necessary to cut through a steel tie. This was accomplished with the same drill steel as was used for the concrete, in the surprisingly short time of 12 min. Blasting was prohibited in this confined place—so close to one of the most congested of traffic arteries—and these drills were called upon to pick out all the material piece by piece. For this work a solid hexagon steel with narrow-pointed chisel about ¾ in. across the cutting edge was employed.

A tunnel is being constructed in Seattle to connect the King County courthouse with the City Hall. This work necessitates the removal of large concrete foundations, for which purpose a Jackhamer is employed. This drill was observed to work at as fast a rate as 1 ft. per min.

Large concrete foundations were removed by this method at the Brighton (England) Corporation Electric Works. The concrete was exceptionally hard, and many of the broken blocks weighed as much as 20 tons each. An ordinary chisel bit 20 in. in length was employed for drilling holes all around the foundation, about 9 in. apart and 18 in. deep. The average speed of drilling was 7 holes per hour—that is, about 10 ft. of hole per hour.

When holes are drilled dry in concrete with hand-rotated tools, the natural moisture present in the concrete seems to cause dust from the cuttings to pack and form a mud collar above the bit, making it necessary to withdraw the steel by means of a wrench, which causes considerable delay. This difficulty is not encountered with the automatically rotated type of drill, because its air jet keeps the hole clean and the steel can easily be withdrawn by means of its holder.—*Engineering News.*

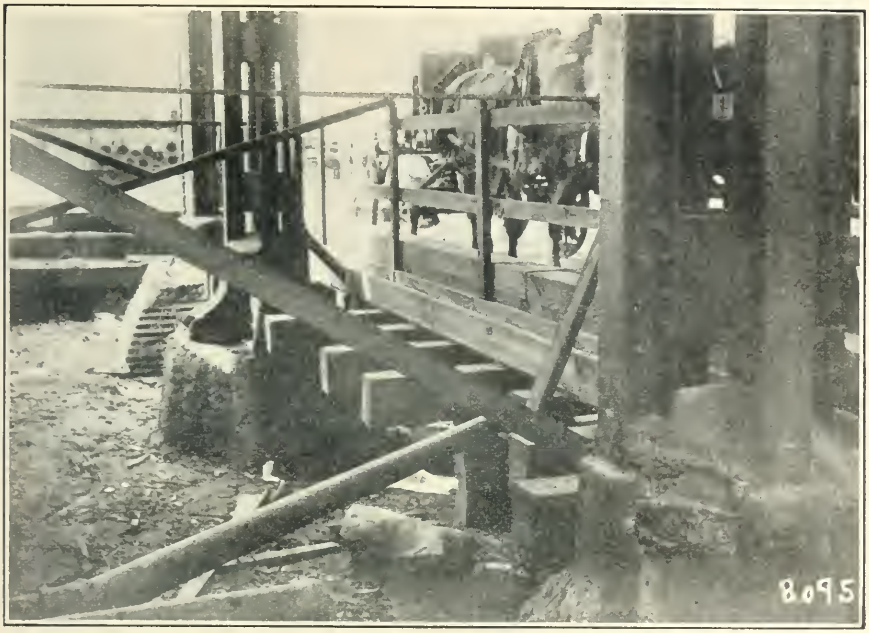


FIG. 4.

HEART ACTION AT GREAT ALTITUDES

The following conclusions, as the result of extensive observation and experiment, are contributed to *La Presse Medical* by Dr. G. Ferry:

The pulse becomes more and more rapid from the ground up to a height of 750 meters. From this height to 1,250 meters it still augments, but less rapidly. Above this height it again accelerates more rapidly. The period of slower acceleration seems to be explained by the fact that between 750 meters and 1,250 meters the air is usually calmer than at lower altitudes, and the wind more regular. Above this height the cold becomes a great factor in acceleration. Each time a gust strikes the aeroplane the pulse accelerates. During a flight at a particular altitude the pulse remains constant. When descent begins there is a gain for a very short period a quickening of the pulse, due, it is thought, to the thrill of excitement experienced when the engine is shut off. After this the frequency falls in a regular manner during a slow descent. Each "event" in the descent causes an acceleration, short, but definite. The pulse at the end of the flight is always more rapid than at the beginning.

VALUE OF BELT TIGHTENERS

Professor William W. Bird, of Worcester Polytechnic Institute, with Francis W. Roys, have been experimentally investigating the effects of atmospheric humidity upon oak tanned leather belting, with the following definite conclusions:

1. If a belt be set up at a low relative humidity, slipping will occur with a marked rise in the humidity, especially if it is accompanied with a rise in temperature.

2. If a belt be set up at a high relative humidity, excessive stretching and excessive pressure on the bearings will result from a decided decrease in the relative humidity, especially if accompanied by a fall in temperature.

3. If a belt be set up at a medium relative humidity the tensions will not be excessive at low relative humidities nor will there be any great danger of slipping at high relative humidities unless accompanied by excessive temperature changes.

4. If a belt be set up at any relative humidity with a spring or gravity tightener, a load 50 per cent. greater than the standard can be transmitted at either high or low humidity without any of the troubles.

A SUCCESSFUL SMALL AIR LIFT

BY H. L. HICKS.

The air lift is widely recognized as a most convenient and effective means of raising water from deep wells, and in many cases it is practically the only device which can be employed. It has generally been considered, however, that it is impracticable to employ the same means for raising water to any considerable distance above the well and especially for conveying water horizontally or in any direction involving sharp turns in the piping.

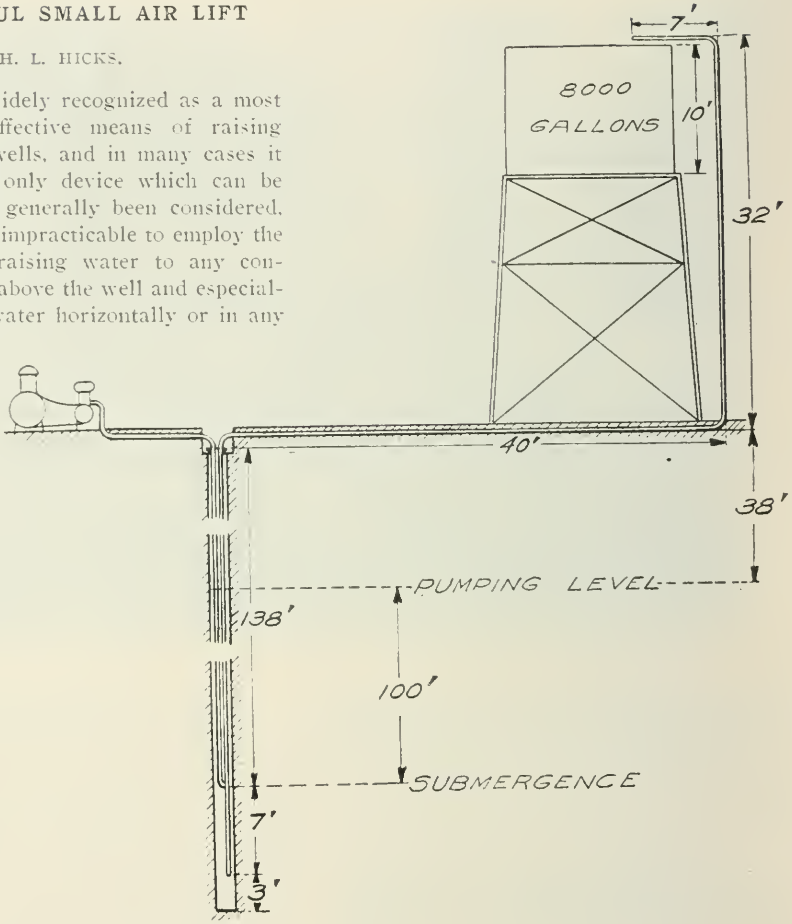


FIG. 2.

The installation pictured in Fig. 1, and shown diagrammatically in Fig. 2, is one that does accomplish this. Water is lifted, in continuous flow, from 35 to 44 ft. (depending on the season), is delivered a horizontal distance of 40 ft., elevated another vertical lift of 30 ft., and discharged after a second run of 7 ft. There are 3 right-angle bends in this eduction pipe. It is a good performance and shows the possibilities of a carefully designed air lift.

This plant is installed on a farm in Antelope Valley, California, and furnishes water for domestic purposes. The single well is 6 in. in diameter and 150 ft. deep. It was formerly pumped with a draw valve pump, and when this was removed the well was found to have become filled with sand to a depth of 70 ft. Upon the installation of the air lift, however, the sand was quickly removed without experiencing any difficulty. As a matter of fact, accumulation of sand is not possible with the air lift in operation.

The water level in the well varies slightly, the static head being 31 to 40 ft., according to the season. The average level is about 38 ft., with a pumping drop of 4 ft. Water is elevated to an 8,000-gal. tank 30 ft. from the ground, making a total life of 70 ft.

The top of the well is 2 ft. below ground level and both air and water pipes are buried for protection. The discharge pipe is 2 in. in diameter and extends to within 3 ft. of the

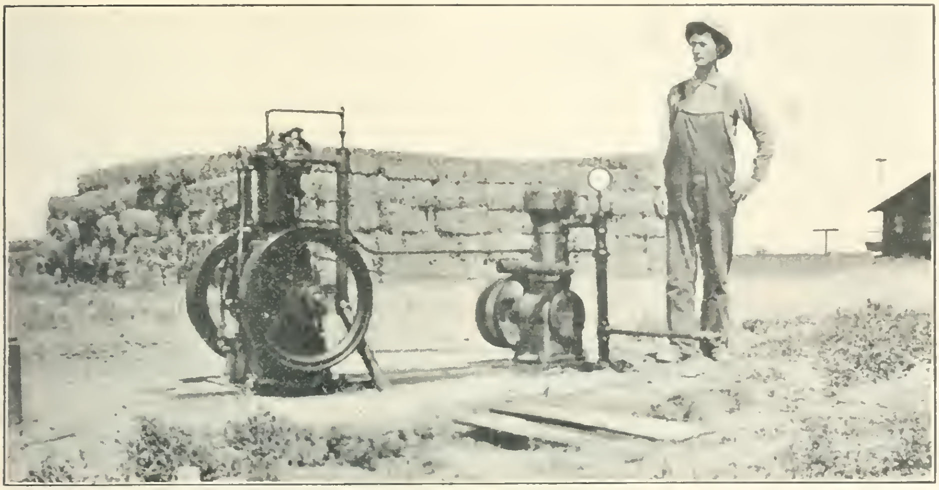


FIG. 1.

bottom of the well. It is fitted with a Lane Standard footpiece placed 7 ft. above the end of discharge pipe. The air supply pipe is ¾ in. in diameter. The running submergence is 100 ft. or about 59 per cent.

Air is supplied by an Ingersoll-Rand, 3½ by 4-in. Imperial vertical compressor with hopper cooled cylinder. This is belted to a Nonpareil, 2-hp. gasoline engine operating at 400 r.p.m. The belt pulleys of compressor and engine are 16 and 20 in. respectively, giving a compressor speed of 500 r.p.m. The air consumption is 11 cu. ft. of free air per minute at a pressure of 55 lb. per sq. in. This is based on a normal pressure of 44 lb. and a friction loss in the long discharge line of 25 per cent. The delivery is 39.8 gal. per min. with an operating efficiency of 35 per cent.

As Fig. 1 shows, the wonderful climate of this particular section of the country has permitted the installation of the air compressing plant in the open, certainly an economy as far as the cost of housing goes.

This plant was designed by J. Warren Lane and installed for Mrs. Mae Whidden Taylor, Lancaster, Cal., by Harry Lee Martin.—*Practical Engineer.*

Raising oil from wells by air-lifts may be more satisfactory than by using pumps. An air-lift is suited to raising liquid containing sand, mud, or slime. At Bakersfield, California, an air-lift in one oil-well raised oil 1,200 ft. with subergence of only 30%.

A HILARITY COMPRESSOR

An Imperial, Type XII, air compressor is being installed at Luna Park, Cleveland, Ohio, to furnish a supply of compressed air for Hilarity Hall, a novel attraction of this popular amusement resort. Some interesting information concerning this installation and its responsibilities is furnished us by Mr. W. A. Armstrong of Cleveland.

Among numerous other specialties in this Hilarity Hall is a novel diversion arranged for the people in the form of local jets of compressed air attacking the person of the visitor at different points of his anatomy. The compressor is installed and operated in the usual manner (and of course not visible in the hall) and connections are led from the receiver to various openings located throughout the hall. These openings are in the floor, in the walls, in the faces of square posts or pillars. These pillars are decorated with comic post cards and other devices to draw the unwary close to them and when the opportunity is ripe an operator in a central box pulls a lever and shoots the victim full of compressed air much to his surprise and mild discomfiture, but absolutely without harm.

The greatest excitement, however, developes when a lady incautiously pauses over one of the floor openings. This is the operator's golden opportunity and he cuts loose with a jet of air which whisks her draperies upward to an interesting height, bringing out a squeal to be heard several blocks away. No accurate data are yet at hand as to the volume of air required for the skirt lifting operation, but no doubt formulas will develope. It must be realized that such data would necessarily be subject to continual change with the fluctuations of fashions, tight skirts, naturally, requiring but a small volume of air, while those which are large and loose may require much more.

This new field of compressed air employment, in connection with the movie industry suggests vast possibilities of development in the not distant future.

VACUUM CONVEYANCE OF FINE DUST*

BY T. C. CLOUD.

In a case where the opportunity was afforded the author of making an entirely new departure in the moving of this class of material, [fine and often poisonous dust] the furnaces were producing a gas highly charged with arsenious oxide. This was, to a large extent, deposited in a complicated system of condensing chambers and flues, followed by filtration through bags in a bag house. The points at which it was necessary to remove the arsenious oxide from the bag house, flues, etc., were numerous, and it was also necessary to deliver all the material to the packing room, where it could be packed in casks for marketing. After considering the existing methods for removal and transport of this material, none of which appeared suitable, experiments were made with a powerful vacuum-producing plant, such as has lately been placed on the market and was originally used for the removal of dust from carpets and household furniture. This class of plant has lately been successfully adapted to the cleaning of boiler flues, and it appeared to the writer that such plant, with certain modifications, might be made suitable for the purpose in view. After some preliminary trials with a small plant, and also with one of double size, an installation was designed and erected of which the following is a description.

The vacuum pump, at normal speed (160 revolutions per minute), has a displacement of 20,000 cubic feet per hour and will produce a vacuum of 18 inches of mercury if all valves to the various branch mains are closed. In the packing house, the pipe main enters a cyclone separator in which the bulk of the arsenious oxide is deposited. Following this is another smaller separator. Finally the air is drawn through a shallow layer of water and then passes to the vacuum pump. The cyclone separator has a small storage capacity and the arsenical soot is automatically removed from this apparatus and discharged into the casks placed below. The smaller separator is furnished with baffle plates and collecting receptacle from which the deposit is only discharged at long intervals when the vacuum is off. The water separator is arranged so that a small continuous supply of water can be passed through it, or it may be charged and discharged intermittently.

The mains about the works are of ordinary gas pipe, which need only be screwed together in the ordinary way. All bends and entering branches are of large radius and, for moving the material npward, all vertical members are avoided and inclined pipes substituted. At numerous points about the works capped branches are arranged, to which, on removal of the cap, suitable flexible hose can be attached; either flexible metallic hose or reinforced rubber hose answers well. A suitable nozzle is fixed at the end of the hose, and on inserting this into the accumulated deposit, the latter is immediately sucked up and conveyed to the separating plant. This plant, having an air pump capacity of 20,000 cubic feet per hour, deals with one and a half to two tons of collected arsenious oxide per hour, and the farthest point from which a branch is situated is about 200 yards from the separator. The pump, in this instance, is electrically driven, and absorbs at the rate of 12 to 14 horse-power. The ease with which collecting hoppers, condensing chambers, flues, etc., are cleared out is remarkable. The men work entirely from the outside, the nozzle end of the flexible tube being pushed into the material, which disappears in a surprisingly rapid manner, and, of course, without the production of the slightest amount of dust. All the annoyance to the men caused by the handling of this material is removed, and respirators are superfluous.

It is easy to see how such a plant may be adapted for the removal and transport of such materials, and many others will probably occur. The writer is convinced, after seeing what can be done in the case of a plant in operation, that a similar plant can be made to work successfully over greater distances and on larger quantities, and there appears no reason to doubt that the system can be satisfactorily applied to deal with any quantity of suitably fine material.

---

*Journal of Society of Chemical Industry.

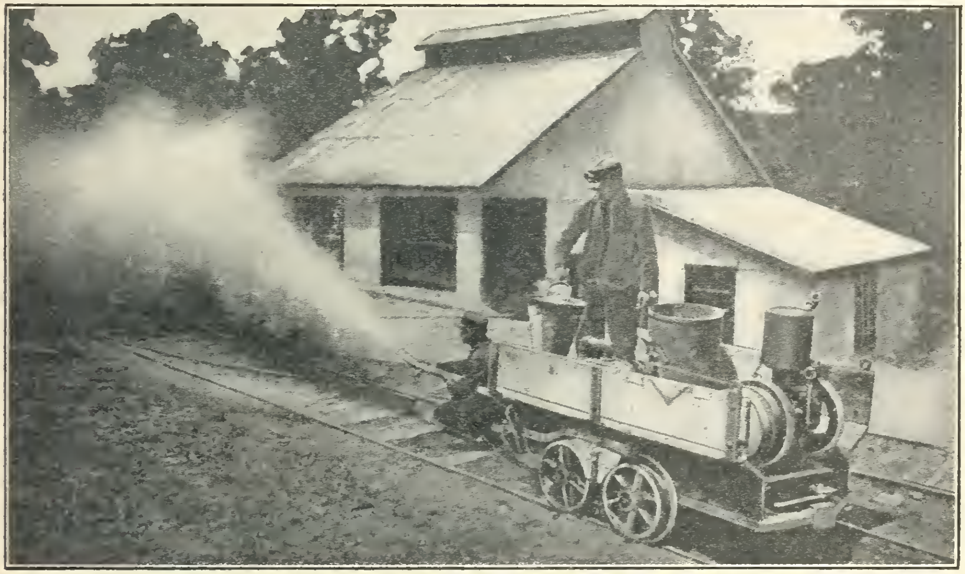


FIG. 1.

ROCK DUSTING TO PREVENT COAL MINE EXPLOSIONS

At the experimental mine of the Federal Bureau of Mines, Experiment, Pa., a large number of explosion tests have been made, under various prepared combinations of conditions, for the purpose of determining the efficiency of rock dust both in preventing mine explosions and in checking their extensive propagation. As a result of the experiments the rock dusting method seemed to have pronounced advantages over the use of water and arrangements were made with a Pittsburgh district company to rock-dust a portion of one of its mines, keeping careful record of costs and other particulars, with constant inspection by Bureau Engineers.

This work was continued for a year, with results so satisfactory that the dusting has been extended to three other mines, and officials of various companies are investigating the system, and the probable wide adoption of the method calls for the development of special machinery to supply the demand.

Rock dusting has been carried on in the Delagua mine of the Victor-American Fuel Company, in Colorado, for more than four years. The first rock dust that was used in the Pittsburgh district was pulverized limestone 75 per cent. of which would pass through a 100-mesh sieve. It was found that material prepared by grinding in a hammer crusher equipped with a 1-16 in. slotted screen was only a little less efficient than the pulverized dust.

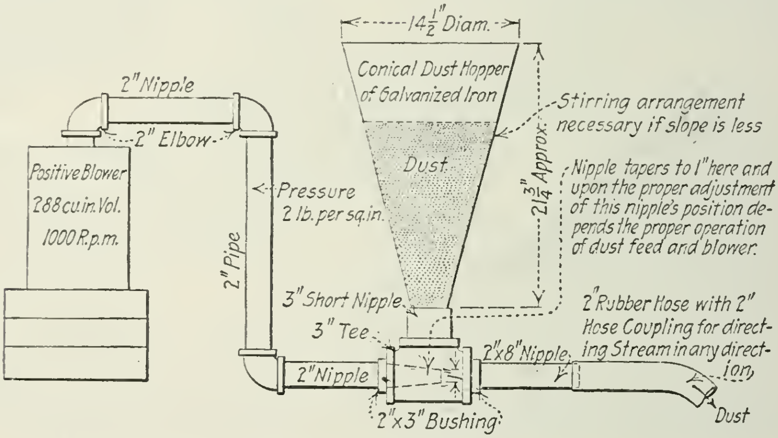
In rock-dusting a mine entry, the best way to apply the first coating is, under most conditions, to throw the dust on by hand, because a thicker and better-distributed coat is thus obtained. In time, coal dust settles on the rock dust, and redusting is desirable. This is best done by a rock-dusting machine, which blows into the air current a cloud of rock dust that settles in a mantle over the coal dust. The use of a machine decreases the cost and greatly increases the convenience of redusting. The photo Fig. 1 shows a machine as used at the experimental mine.

The Director of the Bureau of Mines is addressing crusher and blower manufacturers as follows:

TO MANUFACTURERS OF CRUSHER APPARATUS.

As the result of mine-explosion experiments at the experimental mine and explosion-prevention investigations in the field, the bureau is strongly recommending the use of finely crushed or pulverized rock dust, having no or a very small percentage of combustible matter, as a preventive for coal-mine explosions.

Nearly all mine explosions in bituminous coal mines, once initiated, are extended by the fine coal dust that is found on the surface of most mine entries. This dust, when blown into a cloud, is explosive. If rock dust is thrown on the surfaces it covers the coal dust or becomes mixed with it, and if a sufficient amount is used, the cloud of dust blown from such surfaces in the event of an explosion is nonexplosive and quenches the flame. The more finely divided the dust is, the better it is for rock-dusting. Tests have indicated, however, that a dust all of which will pass through a 1-16-in. slotted screen and having about 40 per cent. through a 100-mesh and 25 to 30 per cent. through a 200-mesh screen is satisfactory for the purpose. Further detailed information concerning the use of rock dust in mines can be obtained from Bureau of Mines Technical Paper 84.


14½" Diam.
Conical Dust Hopper of Galvanized Iron
Stirring arrangement necessary if slope is less
2" Nipple
2" Elbow
Dust
Positive Blower 288 cu.in. Vol. 1000 R.p.m.
Pressure 2 lb. per sq.in.
21¾" Approx.
Nipple tapers to 1" here and upon the proper adjustment of this nipple's position depends the proper operation of dust feed and blower.
2" Pipe
3" Short Nipple
3" Tee
2" Rubber Hose with 2" Hose Coupling for directing Stream in any direction
2"x8" Nipple
2" Nipple
2"x3" Bushing
Dust

Hose may be connected through entry stopping into return air course to make a rock-dust mantle over accumulation of fine coal dust.
When such entries have no track, frequently no attempt is made to treat coal dust.

FIG. 2.

The bureau desires to inform you of this new field for crushing or pulverizing machinery. Information as to whether your company now has machines which will furnish material as fine or finer than that given, the output per hour, horse-power required and cost will be appreciated.

TO BLOWER MANUFACTURERS.

It is desired to call your attention to the demand, which has arisen in connection with the work of prevention of coal-dust explosions in mines, for a machine designed to blow a cloud of rock dust. This will probably be of interest to you, as a positive blower is one of the essential parts of the apparatus.

One of the methods now strongly recommended by the Bureau of Mines for the prevention of coal-dust explosions is to coat the mine-entry surfaces with rock dust so that in the event of an explosion a thick rock-dust cloud will be formed and quench the flame. The first coating of rock dust is thrown on the mine-entry surfaces by hand. After a time some coal dust settles on the rock dust, and it becomes desirable to apply another coating of rock dust. This is probably most conveniently done by the use of the rock-dusting machine. It blows a thick cloud of dust into the air current, which carries it for long distances, the dust gradually settling out and forming a mantle over the coal-dust deposits.

The apparatus, as used at the experimental mine of the Bureau of Mines, consists of a small positive blower, the air from which passes through a 2-in. pipe to the injector chamber into which the rock dust is fed from a hopper; the air and dust, becoming mixed in this chamber, is blown through a hose into the atmosphere.

Fig. 2 shows an outline arrangement of the apparatus. The blower used has a volume of about 288 cu.in. and is run at about 1,000 r.p.m. The pressure in the outlet pipe when the machine is operating is about 2 lb. per sq.in.

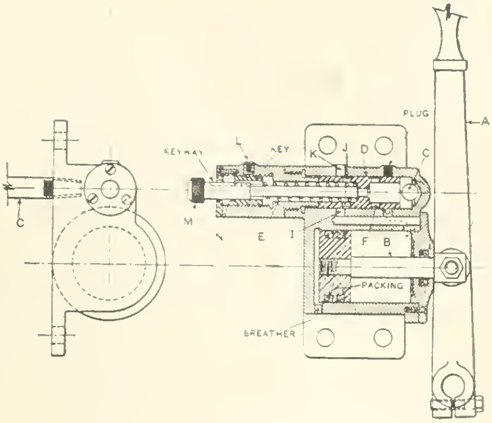
The injector chamber should be carefully constructed. The 2-in. air inlet is reduced to a nozzle of 1-in. opening, and the nozzle should extend far enough into the chamber of the 3-in. tee so that the nozzle opening is below the outer edge of the dust-hopper opening. The dust then falls or is drawn forward into the air stream and is blown through the hose. A flexible hose is desirable for an outlet so that the air stream can be pointed in any direction; also this permits its connection to pipes through stoppings to direct the dust stream into aircourses or entries having no track and which ordinarily receive no treatment to render the coal dust present inert.

As the rock-dusting method of rendering coal dust inert is now being taken up actively, it is believed that there will be a considerable demand for such apparatus. Information as to whether your company could furnish such equipment and the approximate cost of the same would be appreciated.

SAFETY VALVE FOR FALL OF PRESSURE

The automatic air valve here described was designed to prevent accidents on machines equipped with compressed air chucks. Simultaneous demand from a number of air tools or the breaking of an air line is likely to result in a sudden decrease of pressure, and this may cause the work to be released from the chuck. It is to overcome trouble of this kind that the safety valve was designed.

Referring to the illustration, it will be seen that the lever *A* which is used to start or stop the machine is connected to piston rod *B*, but this does not interfere with the normal operation of the lever. Air pipe *C* is a branch from the main supply pipe of the air chuck, and furnishes pressure to operate hardened steel valve *D* which is held back by spring *E* as long as the air pressure in the line remains normal. If the pressure decreases to a point below the minimum required to operate the chuck, spring *E* throws valve *D* back and admits air to the cylinder through openings *F*, *G* and *H*. Any leakage of air past the valve will not accumulate in the cylinder and cause a shut-down of the machine because it escapes through the by-pass and openings *I*, *J* and *K*.



SAFETY VALVE FOR FALL OF PRESSURE.

The tension of spring *E* may be adjusted by loosening a set-screw *L* and revolving knurled rod *M* that is riveted to valve *D*, thus operating screw bushing *N*. As rod *M* moves with valve *D* the position of the valve can be easily estimated; and this is important because if the air pressure is low, it is impossible to start the machine without exerting sufficient force to overcome the total pressure against the piston. This device shuts down the machine if the air pressure falls below the minimum required to hold the work in the chuck; it is sensitive to a varitation in pressure of five pounds per square inch and adjustable for any reasonable range.—LAWRENCE FAY, *Machinery*.

PNEUMATIC MASSAGE

A very effective as well as simple device for obtaining massage of limbs which have been rendered inactive by the ankylosis due to a long inaction in case of maladies, is brought out by Dr. Bergonie, a well-known French scientist. The wounded are subject to this drawback, owing to adherent scars which come from wounds, or by long repose due to treatment of fractures, in which cases the limbs become deadened from lack of movement. He treats the member by a mechanical massage upon the pneumatic principle, by using a large box one of whose sides is made up of an elastic membrane (Marey device). The limb is held in such a way that the membrane comes in contact with it, then when an air pressure is exerted on the box, by the air pump, the membrane swells out and presses on the patient's arm. If the pressure is supplied in the form of pulsations of air, a veritable massage is obtained in this way, and it is very exact, for the pressure can be regulated from high to low by a simple adjustment, through all degrees. Again, the frequency of the pulsation can be regulated within a good range, and can reach 120 pulsations per minute. The present method has a great advantage of needing only a very simple apparatus, and at the same time is powerful and effective.—*Scientific American.*

DRILL-STEEL SHARPENING AT OLD DOMINION MINE

The following notes, reproduced with slight changes, from *Mining Press*, San Francisco, were compiled by I. H. Barkdoll, mine superintendent of the Old Dominion Mining and Smelting Company, Globe, Arizona.

The drill steel used by this company is of four kinds: Leyner steel; piston-drill steel, stoper steel; and Jackhamer steel. Leyner steel is made from 1¼ in. round, hollow keystone bars. It is cut into four lengths: 2 ft. 9 in.; 4 ft. 9 in.; 6 ft. 9 in. and 8 ft. 9 in. Shanks and bits are made on No. 5 Leyner drill sharpener. When sharpening, the gaging is done automatically, only one heat being taken for each shank or bit. The different gages on the Leyner steel are 2½ in., 2¼ in., 2 in., and 1¾ in. Four-point cross-bits are used, with shoulders ⅝-in. thick and cutting edge drawn to 90% pitch. Stoper steel is made from inch grooved Keystone steel cut into lengths of 2, 3, 4, 5, and 6 ft., with bits gaged 1¾, 1⅝, 1½, 1⅜, and 1¼ inch. Jackhamer steel is made from ⅞-in. hexagon hollow Keystone, cut into lengths 2, 3, 4, 5, and 6 ft. and gaged the same as the stoper steel; both the four and six-point bits are used, depending on the ground to be drilled.

Sharpening and tempering of all the steel is by the same process. Hollow steel before heating is thoroughly cleaned and blown out by means of a steel tube attached to a spring-valve on the compressed-air line. A single heat is taken for the punching and sharpening operation, the bits being heated for 2½ in. in a quick fire. After heating, the hollow steel is punched in the centre by an air-punch (made from a No. 2 Leyner drill sharpener fitted with an air-cylinder punch), enlarging the hole sufficiently so that, when sharpened, it will not close. It then goes to the sharpener, where it is sharpened and gaged at one operation. Stoper and piston-drill steel are treated in the same manner except that a shorter heat is taken, as no punching is required, this being all solid steel.

Piston-drill steel is made in the following manner. Starters are cut from 1¾-in. Keystone grooved steel 2 ft. 4 in. long, with shanks drawn on one end to fit the drill-chuck. The 2nds, 3rds, 4ths, and 5ths are made by welding 1¾, 1½, and 1¼-in. grooved steel, cut 2 ft. 4 in., on 1¼ hexagon steel, making the total lengths 4, 6, 8, and 10 ft. The gages for this steel are 2⅝, 2⅜, 2⅛, 1⅞, and 1¾ in. These are also cross-bits, ⅝ in. thick at the shoulder, with the cutting edge drawn to 92% pitch. This steel is standard for all our types of piston-drills such as Sullivan, Wood, Holman, and Ingersoll-Rand 3-in. machines, and does not prove too heavy for 2¾-in. and 2⅝-in. machines. This standardization of piston-drill steel is made possible by having the chuck-bushings in all machines standard, and allowing only one class of steel for each class of drill.

All tempering is done by re-heating, which hardens where hardness is required, while the remainder of the drill remains soft and tough. In tempering with the same heat after sharpening, the drill is often hardened too far back, and the bit is liable to break in hard ground. The tempering heat is as short as possible, with an even slow fire to a cherry red, then dipped in pure water. The water is kept at an even temperature by having the intake-pipe at the bottom and the overflow on top, with the water in continuous circulation. In tempering shanks we heat about an inch of shank, dip, and draw to a light-straw color. Much depends, of course, on the class of steel used. Breakage on our steel averages ½% of the pieces used, or 3 in 600.

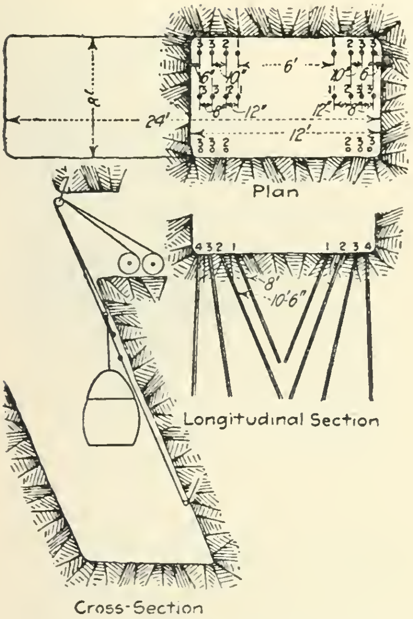


FIG. 1. DRILL ROUND USED IN SINKING CREAN HILL SHAFT

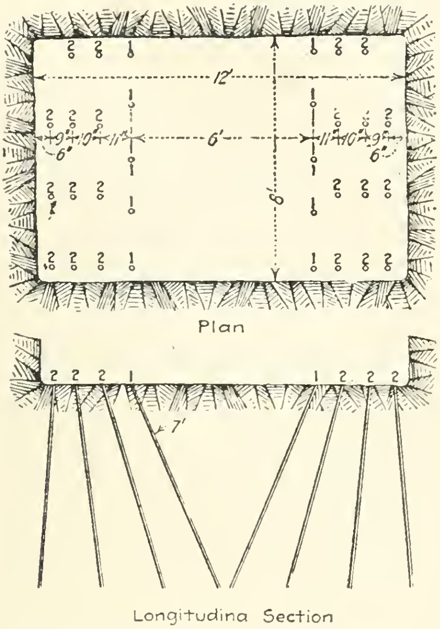


FIG 2. DRILL ROUND EMPLOYED IN SINKING DOMES INCLINE

THREE SHAFT SINKING METHODS

The following, by Albert E. Hall, which we reproduce from Engineering and Mining Journal, will be found interesting. It tells its story very clearly and without waste of words, though suggesting that a little might have been said about the drills employed and their manipulation.

The first method was used at the Crean Hill mine, Ontario, Canada. This shaft was inclined at 68°, and while 24x8 ft., the work was done in halves, each 12x8 ft. Two bars were employed with only one machine in each bar. To give a break in the first half 22 holes were needed. A double cut was used, but only four holes were drilled in the first cut, while six were needed in the outside cut. Six holes on each side, numbered 3 on Fig. 1, made up the rest of the round. The four first cut holes marked 1 were first fired. The second set of six cut holes, marked 2, were fired next; when the shaft had been mucked out, the rest of the round was fired. The cuts usually pulled about 7 or 8 ft., using about 450 to 500 sticks of gelignite to the round. The holes were fired by battery. The shaft was sunk in schist, and the cost was from $22 to $25 per ft. for one half.

Mucking was done into a bucket pulled to the level above by an air hoist placed on the level. The end shaft compartment was used by the bucket while the skip was brought down below the bucket in the next compartment and the bucket dumped into it. The hoist had two drums, the first of which carried the hoisting cable, while the second carried a cable for the bucket trolley to run on. A hole was always drilled near the shaft bottom, in which an eyebolt was placed to which was tied one end of the running cable. When the first half of the shaft had been entirely completed, work was started on the second half, which was stoped down into the first half. Anywhere from 9 to 12 holes were used on the second half and the cost was only about $12 per ft. No time was lost in mucking on the second half. As soon as drilling was finished, the holes were blasted, and after a very small amount of cleaning and scaling the machines could be set up again and mucking started on the bottom of the first half.

In contrast to this method of using the

bucket was that used in a shaft inclined at 47°, which was sunk by the same company at another mine. Here small air hoists were also used to hoist the buckets, which ran on skids, two buckets being used, each having its own hoist and using the two end compartments of the shaft. The hoist-cable pulley, as well as the dump, was on the foot wall of the shaft instead of on the hanging wall as in the previous case. The bucket was automatically dumped over a pocket in the foot wall, and the muck was drawn off from this pocket via chutes, in a drift run behind the shaft, and thence trammed to the rock pocket on the level, from which it was hoisted by the skip with the other mine rock.

The second method is for a flat inclined shaft at the Dome mine, South Porcupine, Ontario, Canada. The slope of this shaft was about 10°, and it was raised. The size was 12x8 ft. In each round 32 holes were drilled. There were five holes, numbered 1 in Fig. 2, on each side of the cut, while four were sufficient for the rest of the round except for the square-up holes, where it was found that three would do the work. Two machines were used on a bar. About 5 to 6 ft. was pulled in a round, and about 25 ft. advance a week was considered fair. The cut was fired first. As soon as the smoke and gas had cleared, the rest of the round was fired. After the incline had advanced a little, the gas was found to cause considerable delay even with the air blowing as is the custom. A water spray was then tried, setting up the pipe before the blast and afterward turning on the water from a valve placed outside the incline. After the spray had run a few moments, the men entered and pulled it to the face, spraying the face, wall, muck and the sides. While before the use of the water it had been necessary to wait probably an hour before work could be started, after its use the men could return almost immediately. The machinemen did no mucking. A small air hoist was placed at the bottom of the incline, and an extra bar was set a short distance behind the machine bar to which extra bar was attached the pulley by which the cars were pulled up for the trammers to load.

The third method was used at a new shaft being sunk at the Creghton mine, Ontario, Canada. All mucking in this shaft was done by the machinemen directly into skips. A good temporary headframe was erected and an electrically driven two-drum hoist installed that was as good as the permanent hoists at some mines. This shaft was 38x8 ft. and inclined at 55°. The same type of cut as that used at Crean Hill was employed, but the shaft was sunk all in one part. Blasting was done electrically, the cut was fired first and mucked out, after which the rest of the round was fired. Three bars were used on each side of the shaft, carrying two machines each, making 12 machines in the shaft. The rounds pulled ranged all the way from 6 to 10 ft., but averaged about 7 ft. Complete and accurate figures were kept of all operations, and an elaborate daily report was made from which a monthly sheet was prepared.

The shaft was sunk in granite most of the way. Considerable time was lost blowing smoke, but when the shaft reached the sixth level, a drift was put in to connect with the old workings, which furnished a strong draft and good ventilation. From the eighth level a drift was driven to the line of the shaft and a raise put up to meet the shaft above. Chutes were constructed at the raise bottom with the idea that muck could be drawn off here after the raise met the shaft and that the machinemen could employ all their time drilling facilitated by stoping the shaft into the raise. The raise proved to be rather small, however, and the muck could not be drawn off quickly enough, so that considerable mucking had to be done. The raise choked up once or twice and had to be blasted down. On the whole it can perhaps be said that the raise hardly justified itself. True, a few additional feet were gained in advance for the month, but since the rock drawn off from the chutes below had to be taken up through the ore shaft and the ore hoisting suspended from time to time, the output was lowered. No figures are available, as to the cost of raise and shaft. It took about 8 to 10 hr. to drill a complete round and about 24 hr. to muck it out and blast.

The Gas Pressure in a tungsten glow lamp when the lamp is cold is about one-half or two-thirds of an atmosphere. Even when hot there is no great excess of pressure, and therefore no fear of an explosion.

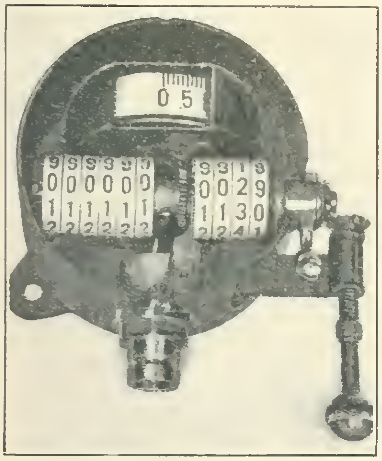


FIG. 1.

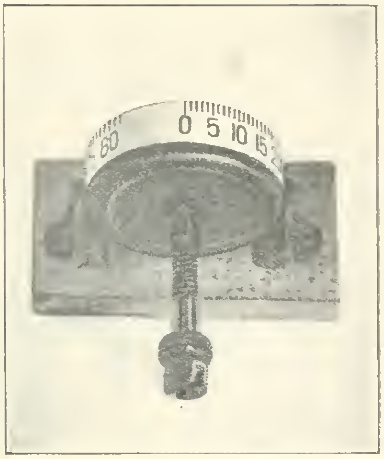


FIG. 2.

AN AIR FRICTION SPEEDOMETER

The half-tones here reproduced from The Scientific American show a run speedometer for automobiles which employs neither the centrifugal nor the magnetic principle, but relies upon the friction of air for its indications. This speedometer has been developed by a leading watch company to a commercial style after three years of experimenting.

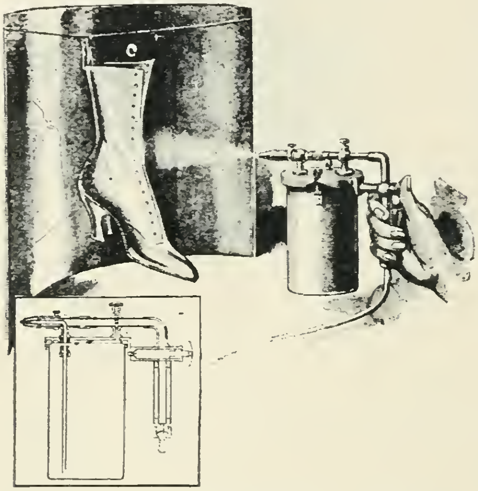
The two main components of the speedometer in question are a driving cup, which is rotated by power from one of the automobile wheels through the flexible shafting, and, suspended over and around it, a driven cup. The driven cup, which is also the indicating one, since the numerals representing the miles per hour attained are marked on its periphery, is inverted over and around the driving cup.

The driving cup of the speedometer comprises two concentric brass cups with a spacing of .108 centimeters between the two vertical walls, called "ribs" for convenience, both of which are rigidly mounted on a vertical shaft so as to revolve in perfect unison. Likewise the driven or indicating cup is made up of two aluminum cups attached together so as to form a single cup insofar as its mechanical operation is concerned. These cups are extremely light, being made of aluminum .008 centimeter thick. This means that 313 of these cup thicknesses would be required to total a thickness of 1 inch.

The driven cup when in position in the instrument has its inner rib floating in the annular space between the ribs of the brass cup, while the outer rib of the aluminum floats outside of the brass cup. There is an air space of .5 millimeter between the ribs of the brass and aluminum cups.

The operation of the new speedometer is of the utmost simplicity: the revolving of the brass cup generates the air friction which, were it not for a regulating hair-spring serving normally to maintain the aluminum cup at the zero marking, would cause the latter to revolve; in other words, the air friction developed serves as a means of transferring the driving power from the brass cup to the aluminum cup. The hairspring is so adjusted as to permit the aluminum cup to be affected by the air friction in direct proportion to the speed of the brass cup, so that the reading of the instrument will be correct.

The air friction developed in the instrument has been proved to be directly proportional to the speed of the revolving cup. It is this fact that has made possible a uniform calibration without introducing compensating devices to gain this end. Comprehensive laboratory tests are reported to have proved that air friction is not influenced by heat, cold or altitude up to 10,000 ft. The revolving cups, contrary to expectations, do not have to be carried in an airtight compartment, and no sealing is necessary. The regulation between the tension of the hairspring and the tendency of the aluminum cup to rotate under the influence of the air friction is so delicate that the instrument indicates immediately all speed changes, and indicates as low as one half mile per hour. Yet the instrument is so sturdy that its accuracy is not affected by vibration in regular service.



COMPRESSED AIR SAVES UNSALEABLE SHOES

When one of the large manufacturing companies found some time ago that it was oversupplied with shoes having light-colored cloth tops, it was decided that the entire stock should be dyed black. In order to accomplish this without ruining the internal appearance of the shoes, a special dye was made and applied by means of compressed air instead of a brush. The device is similar to some of those employed in spraying paint, and practically the same in general principle as an atomizer. The shoes were suspended from a line stretched in front of a screen while being worked upon. The work was done quickly, neatly, and without injuring the linings.

COPPER TO PRODUCE HIGH VACUUM

Finely-divided copper, which may be obtained by reducing a solution of a copper salt and is sold commercially as "precipitated copper," absorbs gases with great readiness, the vapor pressure of the gases thus absorbed being so small that under suitable conditions it may be used for the production of high vacua. A bulb containing a few grammes of the copper is sealed to the vessel to be exhausted, the vessel being then partially exhausted by means of an air-pump and the copper heated to about 250° cent. (482° F.) When the air pump is disconnected and the copper allowed to cool, the residual gases are rapidly absorbed. This absorption is not due to chemical combination, since the gases are liberated when the copper is heated. Great care is necessary when the copper is being used for the first time, as the occluded gases may sometimes be evolved with such violence that the copper is blown through into the pump; consequently not more than one-third of the bulb should be filled with copper; and a short length of the tube connecting the bulb and the pump should be tightly packed with glass wool.

JACKHAMERS AT THE POZO MINE

BY EMMET F. GALLIGAN.*

The writer has recently had the unusual experience of encountering a sulphide ore so extremely hard that it could not profitably be mined with stoping machines. It was nearly impossible to drill holes deeper than 3 ft., as the drill bits would heat to such an extent in a short time that they would batter and it would be impossible to get another steel to follow.

After experimenting for several weeks with different kinds of steel, it was decided to discontinue back-stoping and try mining underhand with jackhamers. It was an easy matter to handle the muck, as there was a ventilating raise through the block at the end of the ore shoot; so two jackhamers were started benching, taking the cuts from the raise. At first not much headway was made, as the benches had to be started in such shape that the ore would run into the raise without any great amount of mucking. As previously found in work with the buzzers, the drill bits of the jackhamers would heat in the dry holes and there was no available water closer than the second level below. Therefore a pipe line was laid to the water supply and a 500-gal. tank installed with air connections, so that the water could be forced through the pipe to the machines. Each jackhamer was then equipped with a water hose, clamping it to the machine just above the steel holder, and on the end of this hose a nozzle valve was used so that the machineman could regulate the water to clear the hole but not use an excess. At this point the grief was ended, as the water cooled the drill bits and it was found possible to drill holes to any desired depth. The tonnage broken per jackhamer was greater than it had been possible to break with three buzzers in the backstope.—*Engineering and Mining Journal.*

---

*Superintendent Pozo Gilpin Co., Idaho Springs, Colo.

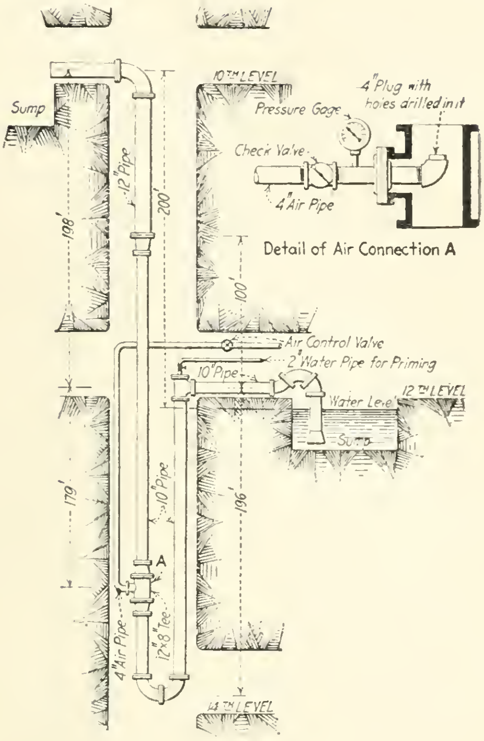
AIR LIFTS AT OLD DOMINION MINE

BY P. G. BECKETT.*

An air lift was installed from the 12th to the 10th level and later one from the 10th to the drain tunnel. The submergence on the air lift from the 12th to the 10th level was 177 ft., of 47%. The top 100 ft. of the column was made of 12-in. pipe; the bottom 100 ft. and the two legs were of 10-in. pipe. The air was supplied from a 4-in. line at 80 to 90 gage pressure.

Short tests on this air lift showed that it handled to the 10th station over 1,650 gal. per min., with an air consumption of 1,080 cu.ft. per thousand gallons. The highest efficiency obtained was 36%. In the lift from the 10th up to the drain tunnel, which was 431 ft., the submergence was 188 ft., or 30.4%. The top 200 ft. of the column was 12-in. pipe, while the bottom 231 ft. and the two legs were of 10-in. pipe. The air was supplied through a 4-in. pipe at a gage pressure averaging from 90 to 100 lb., but which was always kept as high as possible. This lift delivered to the tunnel 1,233 gal. of water per minute, with an air consumption of 2,681 cu.ft. per thousand gallons delivered. The maximum efficiency showed practically 30%.

During the period of unwatering the 16th level, the two columns on the 18th level Aldrich pumps were converted into air lifts, one delivering to the 14th level and the other one to the 12th. The water at that time stood 36 ft. above the 16th level. These lifts were made up as follows: A 3-in. air line provided with a foot-piece made from 3-in. steel tubing, plugged at the bottom and perforated with $^3/_{16}$-in. holes drilled at a 45° angle, was lowered to the sweeps connecting the columns with the pumps. Both lifts pulled the water through the valves and suction of the Aldrich pumps and delivered to the 14th level about 1,300 gal. per min. and to the 12th about 1,000 gal. per min. The accompanying sketch gives the arrangement of the piping used on the 200-ft. air lift.



AIR LIFT AT OLD DOMINION MINE.

QUARRYING AT THE EDGE OF THE OCEAN BED

There is one fact that has made the production of Canadian grindstones among the most interesting of all quarrying operations in the world. The ledges of stone that are utilized are on the coast line and extend out into the ocean. Much of the stone is actually extracted beneath the sea level. One of the most important centers of the industry is at Stonehaven, Gloucester county, New Brunswick. Here are located the quarries of the

---

*From advance copy of a paper: "The Water Problem at the Old Dominion Mine," for the Arizona meeting of the A. T. M. E., Sept., 1916.

Read Stone Company, which have been operated for sixty years. The areas worked have been reclaimed from the sea by the building of dams. This has been no small undertaking. The dam around the present quarry which has just been finished, is over one-quarter of a mile long, and in all about a mile of dams has been built here. Anyone who has seen the Bay Chaleur in a storm will know that these dams are no flimsy affairs. They have been built chiefly of timber crib-work filled with stone and heavily rip-rapped on the side exposed to the sea. The dams have been made water tight by the use of a clay puddle pounded tight.

After the dam is built the water is pumped out and quarrying operations start. The stone lies in horizontal sheets of varying thicknesses, the total depth of rock being about 25 feet. A steam channeller, steam and air drills are used as required, and by the use of these and with powder and wedges the rock is quarried to the required size. It is then hoisted to the "dump" where the stone-cutters take it and shape it round. From there, if it is not too thick for a single grindstone, it goes direct to the lathe to be finished. If the block is say two or three feet thick it is sent to the saws and cut to the required thickness. This applies to the larger stones, say 48 inches in diameter and larger. The smaller stones are split out of the irregular shaped pieces that come out along with the larger stones. The stones are cut round and shaped as a rough grindstone. In the olden days the grindstones were finished by hand by means of chisel and mallet. Now the rough grindstone is taken to the mill where the eye is drilled and the stone turned on a lathe in a very short time. Indeed an expert turner will finish a small stone in five minutes.

DANGER IN COPPER CARBIDE LAMPS

In Miners' Circular No. 18, of the United States Bureau of Mines, on "Notes on Miners' Carbide Lamps," there is the suggested rule, "Never use carbide in a lamp made of copper; the lamp may explode." It seems that there was an instance wherein a carbide lamp made of copper exploded, presumably due to the presence of copper acetylide. The circumstances, as related, were that the lamp was placed on an anvil and struck with a hammer, resulting in an explosion. The precaution referred to was suggested because, under similar conditions, a carbide lamp made of copper might be made to explode following a fall of rock, particularly if the lamp was resting on the floor of the mine. The chemistry of the case is being investigated.

TELESCOPE TELLS OF AIR CURRENTS

The following is by Prof. W. H. Pickering, in charge of the Harvard Observatory at Mandeville, Jamaica:

If we point a telescope on a bright star, remove the eyepiece, and place the eye near the focus, we perceive a bright disk crossed by dark fluctuating dots or lines. These are due to currents in our upper atmosphere. The same result is obtained if, instead of removing the eyepiece, we draw it out a few millimeters beyond the focus. In the latter case, if we determine the number of millimeters we can readily compute the altitude of the current whose motion we are observing. The dark lines travel longitudinally in the direction followed by the current. At Mandeville the "seeing" is never very bad, except when a hurricane is in the neighborhood. At such times the mode of observation above described gives timely notice of the approach of a hurricane, and also furnishes a means of studying the movements of the upper currents in connection with these disturbances.

THE CHEAPEST BLOWER

There are over 800 miles of underground water piping in the Rand mines and over 150,000,000 gallons of water are used every month underground. Fans, having a capacity of 4,500,000 cubic ft. of air per minute, have been installed.

Let us see about this fan capacity. An acre is 208 ft, square. Say that a storm wind is blowing at 50 miles per hour and that the vertical depth of the air current is one mile. Then, if we figure correctly, the volume of air traveling across the acre per minute will be more than 1,000 times (1,073) the above volume delivered by all the fans of the Rand. This might set us to thinking a little about the horse power required, merely to keep up the air circulation of the earth, but we generally are content to assume that the wind just blows itself.

COMPRESSED AIR
MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE

Compressed Air Magazine Company
Easton, Pa.

New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. JUNE, 1916. No. 6

CONTENTS

Deep Hole Drill Wagon 8003
Lighting the Panama Canal 8008
Hand Drills in Structural Work 8009
Heart Action at Great Altitudes 8011
Value of Belt Tighteners............. 8011
Small Air Lift 8012
Hilarity Compressor 8013
Vacuum Conveyance of Dust 8014
Rock Dusting to Prevent Explosions .. 8015
Safety Valve for Fall of Pressure 8017
Drill Sharpening at Old Dominion 8018
Three Shaft Sinking Methods 8019
Air Friction Speedometer 8021
Copper to Produce High Vacuum 8022
Jackhamers at the Pozo Mine 8022
Air Lifts at Old Dominion Mine 8023
Telescope Tells of Air Currents 8024
The Cheapest Blower 8024
Preparedness for Peace or War 8025
Death of Professor Sweet 8026
Liquid Air Explosives 8027
Piping for High Pressure Gas 8029
How Air Shocks Kill 8029
Notes 8030
Patents 8032

PREPAREDNESS FOR PEACE OR WAR

Although we are settling into the habit of talking as little as possible about the world-war which rages still unchecked, it yet subconsciously dominates all our thoughts, and especially that which strives to pierce the future, for we have not ceased to believe that before long absolute, and we may hope permanent, peace will prevail.

The war was not only in itself a surprise to the world, being something, at least in the overwhelming magnitude and horror of it, which all had deemed evermore impossible, but it has also surprised the world in the novelty of the unusual methods employed and in their unparalleled potency.

Two novel devices first successfully employed in this Twentieth Century have revolutionized the war habits which all the previous ages had laboriously developed. The submarine and the aeroplane, not forgetting the zeppelin, have fundamentally transformed the strategy of both attack and defense.

The submarine and the zeppelin we can scarcely think of as ever to be usefully employed for any peaceful purpose. Their sole ability seems to be in the line of destruction, the one by hurling torpedoes and the other by dropping bombs with boundless uncertainty of aim. It is to be noted that both of these are exposed to unusual risks, and that the probability of short careers attends them, with short life for their crews.

With the aeroplane in war the case is very different. It is not essentially a craft of much account in actual offensive operations. It cannot carry great weights of explosives, and in no case can it drop them with any precision. This is not in any way to belittle the services of the aeroplanes in the strategic movements of the war. It may easily be believed that their aggregate services have counted for much more to both contestants than have those of the submarines and the zeppelins. The older and, as we may say, standard systems of picketing and reconnoisance have been superseded by the larger scope of vision and the accurate mapping of the field from overhead, so that all the larger movements of the foes are known as they occur, and surprises are impossible.

The surprises of the present war suggest some need of caution in anticipating and preparing for the possible demands ahead of us.

The future of the submarine and also of the zeppelin for large and constant employment in war may be doubtful. Even our greatest warships are constantly superseding each other, so that in a decade they are successively rendered absolete, and apparently the most staying qualities are after all in the aeroplane whose most insistent characteristic is instability. The aeroplane is unique in that it is equally ready for all peaceful employment and without change it is also fully equipped for most effective war service.

We may reasonably expect in the natural course of events that future developments of this infant prodigy of invention may reveal possibilities as yet little thought of and lead to its employment in vast numbers, not only for rapid transit in all directions but also for purposes of pleasure and diversion, all of which must mean also constant readiness for emergent duty. As the costs of warlike equipment go the aeroplane has the merit also of comparative cheapness in construction, operation and maintenance, and it would seem that a mild appropriation in its interest must be a wise investment for the government. But, whether or no, all who are perfecting and multiplying the aeroplane are working for preparedness.

DEATH OF PROFESSOR SWEET

Professor John E. Sweet died suddenly at his home in Syracuse, N. Y., May 8, in his 84th year. He was educated in the public schools and when 18 he was apprenticed to a carpenter, the next year he was in an architect's office and developed skill as a draftsman. He was associated with various concerns in this capacity, for a couple of years of the time in England. He devised a typesetting machine which was exhibited at the Paris Exhibition of 1867. Then he was for a time a bridge builder and also built the first "straight-line" engine.

All of this is to be regarded as preliminary to his life career, which may be said to have begun when in 1873 he became professor of mechanical engineering in Sibly College of Cornell University. After six years at Cornell he took up the commercial development of his straight line engine at Syracuse, which has been his principal occupation ever since.

To his latest day he never ceased to be the professor, the instructor, to the mechanics and engineers of the world. He was perhaps the best known and certainly the best loved engineer in America. He was untiringly kind and helpful and suggestive. He was a frequent writer for the technical press and led in the transformation of shop and mechanical engineering practice of the last fifty years. He was a leader in the founding of the American Society of Mechanical Engineers, was one of its earlier presidents and was made an honorary member in 1904. He had been president of the Engine Builders' Association of the United States. He had served as mechanical expert for the U. S. Navy Department and in 1893 was one of the jurors of the Chicago Exposition. Syracuse conferred on him the honorary degree of Doctor of Engineering.

WORLD'S LARGEST OIL WELL

Under a pressure of 1,035 lb. per square inch and flowing at a rate of 260,000 bbl. a day, a well, known as Cerro Azul No. 4, near Tampico, Mexico, and said to be the greatest oil well in the world, was recently brought in by the Mexican Petroleum Company, Ltd. The well casing had been tested to a pressure of 1,050 lb., which was practically equaled by the pressure registered after the well was closed. The force of the escaping gas under this pressure blew the 2-ton drill bit out with it and threw it 125 ft. from the well. Its cable became entangled with the valve at the top of the casing and tore the latter off. The drill bit and the escaping oil, which subsequently rose to a measured height of 600 ft., demolished the derrick. It is estimated that 1,000,000 bbl. escaped before the flow was shut off by sliding an extra valve over the casing in a tongue-and groove track clamped to the head of the well. More than half of this oil was saved in temporary reservoirs, and the rest of it was burned after it had run some distance from the well and before it left the company's property.

Air drill hose is often affected unfavorably by miners pouring oil in the hose itself before connecting to the drill machines. This saves them the labor of unscrewing the oil plugs and replacing them. The oil may be good for the drill but surely is bad for the hose.

LIQUID AIR EXPLOSIVES

Readers of Compressed Air Magazine have not found in its pages much encouragement to believe that liquid air has a large future as an explosive for mining and other purposes. We reproduced in a recent issue, and for just what it might be worth, an account from a German publication of the apparently successful use of liquid air as an explosive agent at Charlottenburg. The following, from *Mining Magazine,* London, puts the matter in a clearer light.

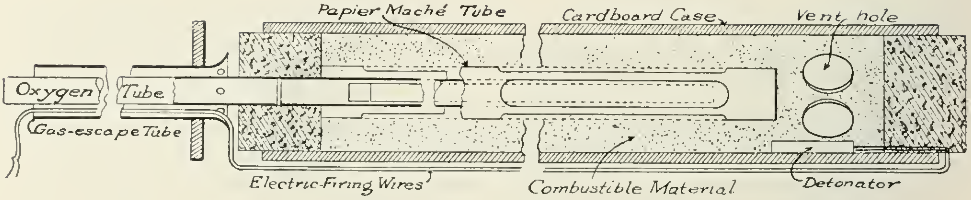
Paragraphs have appeared in German technical papers and in the press of neutral countries, which have subsequently been copied into English and Colonial papers, describing the application in Germany of liquid air as a substitute for ordinary mining explosives. Details are given relating to its application on the Rammelsberg mines, with particulars of the cost of manufacture and use. The cry is that this use of liquid air has partly obviated the necessity of relying on nitro explosives, and to that extent has nullified the British blockade which prevents the delivery of Chile nitrate to Germany.

A GERMAN RED HERRING.

We believe, however, that this is a typical German red herring devised to withdraw attention from the fact that nitric acid is now made chiefly from the air by methods published long before political bias could be suspected.

To avoid confusion in the minds of readers unacquainted with the subject, we may prefatorially state that, broadly speaking, modern explosives may be said to be made by treating various organic substances with nitric acid, the nitro body or nitrate thus formed being used with or without a mixture of various oxygen-carrying salts such as ammonium nitrate, and sodium and potassium nitrates. Formerly nitric acid was entirely and still is largely produced from a natural nitrate, such as is obtained in Chile, by the action of sulphuric acid. Of recent years, however, the acid has been made on a considerable scale by the fixation of atmospheric nitrogen, either directly by electric discharge through air, or indirectly through the production first of ammonia, and the subsequent conversion of the latter by means of platinum sponge as a catalytic agent. The use of liquid-air compositions as substitutes for nitro-explosives was first proposed about twenty years ago, when Linde succeeded in producing liquid air on a commercial scale. At first it was supposed that liquid air by itself, placed at the bottom of a hole, if properly confined and heated to the temperature of the rock, would provide sufficient energy to rend or disrupt the rock. But the time required to transport the liquid air from the place of manufacture to the place where it was used, and to charge the hole, was too great; and, moreover, it was expected that it would disrupt the rock by accumulated pressure due to absorption of heat rather than by detonation. Linde subsequently presented the idea in a new light when he suggested that liquid oxygen should be used in preference to liquid air, owing to the greater capacity of the former to support combustion, and thus, when mixed with suitable organic substances, to promote conditions favourable to a rapid combustion or even detonation. When air is liquidfied, its two chief components can readily be separated, and both oxygen and nitrogen can thus be obtained for various industrial purposes. One of the uses of nitrogen produced in this way is to convert calcium carbide into cyanamide, a substance that subsequently can be made to yield ammonia. Linde then evolved the explosive known as "Oxyliquit." He found that liquid oxygen, 90% pure, brought into contact with powdered charcoal or with petroleum absorbed in kieselguhr, produced a mixture capable of detonation; in fact, a very powerful explosive mixture was formed. But a great many difficulties were encountered in applying the discovery to practical blasting work, for the tendency of the liquid to assume the gaseous condition renders it almost impossible to load and fire the bore-holes before so much of the oxygen has escaped as to render the mixture practically non-explosive. Its industrial use therefore remained in abeyance for some years.

The method of applying this invention to rock-blasting is to make a cylindrical cartridge containing an annular cylindrical layer of powdered charcoal or mixture of petroleum and kieselguhr held in place by gauze. The cartridge case is made of cardboard, and it is fitted at each end with a cork. The liquid oxygen is introduced by a papier-maché tube which passes through one of the corks.



SECTION OF THE "OXYLIQUIT" CARTRIDGE.

The liquid is distributed through a loosely fitting cylinder having large gauze ports, and it passes through this gauze into the absorbent combustible material. Vent-holes are provided, so that gasified oxygen may escape to the surface. This gas passes up an outer tube as shown in the illustration. The detonator is arranged at the bottom of the cartridge and the electric-firing wires are brought to the surface through the outer tube. The supply of liquid oxygen is brought to the bore-hole in a vacuum flask. This flask has a special stopper that will screw to a flexible iron tube connected with the papier-maché tube of the cartridge. The stopper is fitted with copper rings which serve to conduct heat from the atmosphere to the inside of the flask, and thus to evaporate sufficient of the liquid to serve to drive the rest into the cartridge. By this arrangement the oxygen can be driven along a hole in any direction.

On reading this account, a number of practical considerations will immediately arise in the minds of mining engineers. For instance, as the explosion must be brought about as soon as possible after the oxygen is introduced, it is impracticable to fire many shots in the same round, and the method would be unsuitable underground or in any other situation where a substantial amount of time is occupied in transferring the men to a place of safety. The method could, however, in some circumstances conveniently be used for quarrying or in the excavation of railway cuttings or foundations for buildings or other structures. The engineer will want to know the cost of the oxygen mixture as compared with an ordinary explosive, and he naturally does not relish the idea of having to manufacture his own explosive on the spot and to make his own charges as required. The danger of allowing the liquid oxygen to be enclosed after it leaves the vacuum flask, and the necessity for dashing to a place of safety and igniting the charge as rapidly as possible, are two factors causing substantial inconvenience. The question arises as to the minimum diameter of the hole necessary to accommodate a cartridge of the new composition equivalent to the standard strength. A hole of at least 2 inches diameter will be required, a size not conducive to economy in drilling. Another point is that to secure the safe placing of the cartridge, it is necessary that the hole shall be even and straight. The objection can be urged that the strength of the charge can only be regulated by the size of the one cartridge used in each hole, instead of by increasing the number of cartridges. If such variation in the strength of the charge is desired, it is necessary in the case of the new composition to have a variety of cartridges of different lengths, or to drill wider holes and have cartridges of varying diameters. But in any case the bulk of the cartridge lengthwise, as well as in diameter, required to produce a given effect is so much greater than when ordinary explosives are used, that its relative efficiency and the relative cost of drilling are very much against its adoption. The question of fumes emanating from this type of explosive has to be considered. It is claimed that the fumes are quite innocuous and not perceptible, but engineers who have had the opportunity of making independent investigations are far from corroborating this claim. The necessity for the hole to be dry is obvious, for any water present would be immediately frozen by the liquid oxygen, which would then be unable to mix with the organic material and no explosion would occur. To counter-balance the disadvantages, the Germans assert that the cost of "oxyliquit" is a quarter of that of blasting gelatine. but the conditions assumed in making this estimate must be known before the figure can be accepted as a guide. It is stated also.

that the strength of the explosion obtained lies between those of blasting gelatine and gelignite. One advantage that may be rightly urged in favour of this method is the absence of danger from misfires, for in case the detonator fails the charge soon becomes harmless owing to the evaporation of the oxygen. We have in the above description indicated the principle of the method, and have weighed some of the advantages and drawbacks. Our readers will probably agree with the view expresed in our opening words, and will judge the value of the process to be political rather than industrial.

PIPING FOR HIGH PRESSURE GAS TRANSMISSION

BY S. LORD.*

In the matter of strength, present-day demands require a very high standard. Coal-gas lines use what are called high pressures, but their range is never up to 100 lb. Natural gas pipe lines are laid in small sizes near the wells to control pressure up to the limit of the rock pressures, which in some cases run up to 1,200 or even 1,400 lb. The small lines carrying such pressures to the nearest gate or reducing station hold against breakage very successfully, but the frosty couplings show very clearly the expansion of leaking gas. Fortunately, these extreme pressures are never carried any distance from the well, or for any length of time, without natural reduction due to expansion into the large space of a big pipe line. Main lines of large size are now in fairly common use, carrying pressures up to 350 or 400 lb., and it is necessary that such joints be bottle-tight under such conditions. It is no simple proposition to confine gas at such a pressure in a pipe of 20 in. diameter, but coupling manufacturers have solved that question fairly well. Oil lines of 10 in. diameter now work continuously at pressures up to 700 lb., while in 6-in. and 8-in. trunk lines crossing the greater portion of the continent, pressures run up to 900 lb. Many gas engineers believe that pressures between 500 and 800 lb. will soon be used on large transportation lines, since the most economical way to carry a large volume of gas is to keep it at a very high pressure. Boosting pressures from 100 to 300 lb. have enabled gas companies greatly to increase the carrying capacity of their lines. Boosting to 600 lb. and continuing to boost whenever there is a slight fall in pressure will work wonders where the lines are sufficiently long to carry the system out with economy. It is easy to appreciate the strength required in pipe couplings to hold without any leakage the hundred or more million cubic feet that a large line will carry under such conditions.

HOW AIR SHOCKS KILL IN THE TRENCHES*

After each of the recent battles it has been shown that, although most of the bodies bore traces of projectiles, there were others without apparent wounds, that preserved the attitude in which they were at the moment of death. It was generally admitted that these died of shocks, from an instantaneous stoppage of the circulation; but no further explanation was possible.

This was the state of affairs when M. Arnoux told at a meeting of the French Society of Civil Engineers how a French officer at the front had found a pocket aneroid barometer which had been put out of commission by the nearby explosion of a German shell. Its stoppage was found to be due to the fact that one of the levers for transmitting the movements of the aneroid box to the pointer, which normally rests on the other lever, had passed beneath it. This could only have been due to abnormal inflation of the box, caused by a considerable barometric depression.

The two levers were replaced in normal position, and the machine was placed under the bell of an air pump. By lowering the pressure little by little, the experimenter showed that one lever shipped under the other when it reached a degree of exhaustion about equal to that at the top of Mount Blanc, at the elevation of 15,000 feet.

We may logically conclude, then, that the explosion of the shell caused a brief barometer depression corresponding to the pushing back of the air at a rate of about nine hundred feet per second. Under such a pressure all nearby objects are thrown down and all living beings are physiologically destroyed by the violent displacement of the air, while those sheltered behind any obstacle can be affected only by the static lowering of pressure in the surrounding atmosphere.

---

*Engineers' Society of Western Pennsylvania.

**La Nature*, Paris.

Now, the effects of lowering the barometric pressure have been observed in aeronautics, when a too-rapid ascent has occasionally been fatal. We know that the blood holds in solution air and carbonic acid, in larger proportion as the pressure is higher, and that these gases separate out as bubbles when the pressure is lowered, precisely as happens when a bottle of soda water or champagne is opened. In this case the bubbles escape from the bottle, but in the human body they are caught in the capillaries, where they stop the circulations of blood instantly.

The phenomenon is dangerous only when the lowering of pressure is very sudden, for the bubbles are dangerous only when they are large enough to obstruct the capillaries. Death is said to occur from "gaseous embolism."

The effects produced by shell explosion have thus been long familiar in other fields. Observed in aeronautics, they are also known among workmen engaged in tunneling. Working at depths of 75 to 100 feet, and thus subjected to pressure of two and one-half to three atmospheres, their return to normal pressures must take place very slowly, to enable the gas in the blood to escape in small bubbles.

In case of violent increase and decrease of pressure produced instantaneously by explosion, gaseous embolism affects all the blood vessels in the organism and instantly arrests all muscular action. This is why soldiers thus attacked preserve the attitude in which the double phenomenon has surprised them. Death occurs with lightning rapidity.

COMPARATIVE TESTS OF ROCK DRILLS

The driving of the Wilson Avenue, Chicago, 8 mile waterworks tunnel under the direction of John Ericson, city engineer, with Henry W. Clausen, engineer of construction in direct charge, afforded an opportunity for comparing the performance of different types of rock drills, and a summary of the results obtained was embodied in a recent paper by Mr. Clausen before the Western Society of Engineers.

It was decided that the best way to determine the most efficient type and make of drill for any particular rock formation would be to equip the different shafts with drills representative of the different types. Accordingly the old piston type of drill, the water-piston type and the water-hammer type were used.

The results found up to Jan. 1, 1916, were that the most economical type of drill from the standpoint of repair parts is the piston. The fastest drill is the water-hammer drill, but the difference between the drills is not marked in either comparison. The hammer drill, however, uses less air than the piston drill.

The specifications called for drills with not less than 2⅝-in. cylinder diameter and a capacity of 10-ft. holes. The cost of the better grade of piston drill of this size was given as $193, of the water-piston drill, $229.60, and of the water-hammer drill, $280; all equipped complete with a 50-ft. length of hose.

Both the column and heading-bar methods of mounting the drills at the face were tried, and the advantage thus far seems to rest with the column method. Bench holes were drilled from the column or bar as much as possible.

THE LEYNER DRILL SHARPENER.

After the tunnel work had advanced for some time it was found advisable to install a No. 5 Ingersoll-Rand Leyner drill sharpener with the necessary dies, dollies, etc. This machine, which is operated by compressed air, holds and forges the steel. The cost of the machine with all appliances was $1,379.55. It is operated by one man and easily performs the work of four blacksmiths and does the work better, said Mr. Clausen.

NOTES

According to a trade circular, "Blow Guns," are used for cleaning type, electros, wood cuts, newspaper plants and *magazine publishers*. [Our italics. Ed. C. A. M.]

Notwithstanding the everlasting mixup in Mexico, The Mexican Mining Journal for May comes to us on time, beautifully printed, filled with excellent matter and giving every evidence of confident life. The Journal has opened a branch office at Tampico, Mexico, the center of what are said to be the world's greatest oil fields, and hereafter it will publish a special oil section which will cover this important branch of the Mexican Mining industry.

The heaviest substance known is osmium, which has, bulk for bulk, nearly twice the weight of lead. The specific gravity of gold is about 19¼, while that of osmium is nearly 22½.

Mexico, despite the deplorable conditions existing, is exporting more silver to the United States than for the last 20 years. It comes from the San Luis Potosi district, from which place over 8 tons were imported in 2 months.

The Ford Motor Car Co. built 58,329 cars in the month of March, the largest production record in its history. On March 25, the company turned out 2,763 cars, the largest day's production. This was at the rate of nearly two a minute for twenty-four hours.

According to an Austrian railway paper the railways in the countries of the Central Powers have substituted metallic flexible connections for the rubber hose used for continuous brakes, and steam-heating apparatus and a coal tar oil for lubricating the axles of rolling stock. The latter is made principally from anthracene, and is in various grades of viscosity, according to the purpose for which it is to be used.

H. W. Bailey, Mutual Life building, Seattle, is testing and developing a dry concentrating machine, in the operations of which compressed air is employed instead of water. He expects to have some practical tests made in the field.

Over three and a half million tons of cherry pits are thrown away at the canning establishments of this country. This would make 200 tons of fixed oil worth $80,000, 6,000 pounds of volatile oil worth $60,000 and 350 tons of meal, worth $14,000; a total of $154,000, besides more than 5,000 gallons of pure alcohol, 20,000 gallons of syrup or 85,000 gallons of jelly. A factory in Oregon is planning to utilize these waste pits.

An ingenious, although simple, application has been found for electric fans in winter for improving both the warming and ventilation of rooms. The fan is so placed as to throw a current of air on the lower part of a steam radiator, which results in the heating of a much greater volume of air than would take place under ordinary circumstances in an equal interval of time. This use of the fan also induces a circulation of the air that tends to improve the ventilation.

Changes in the conditions governing the use of gas for domestic purposes have caused the New York Public Service Commission to consider altering the method of testing it, on the grounds that modern appliances require that gas should have a heating value only, and that the present candle-power standard was a hindrance to distribution without corresponding advantages, in that it increased the cost because of the rising price of the enriching oils that had to be added, and the present standards were wasteful and burdensome both to the consumers and to the companies.

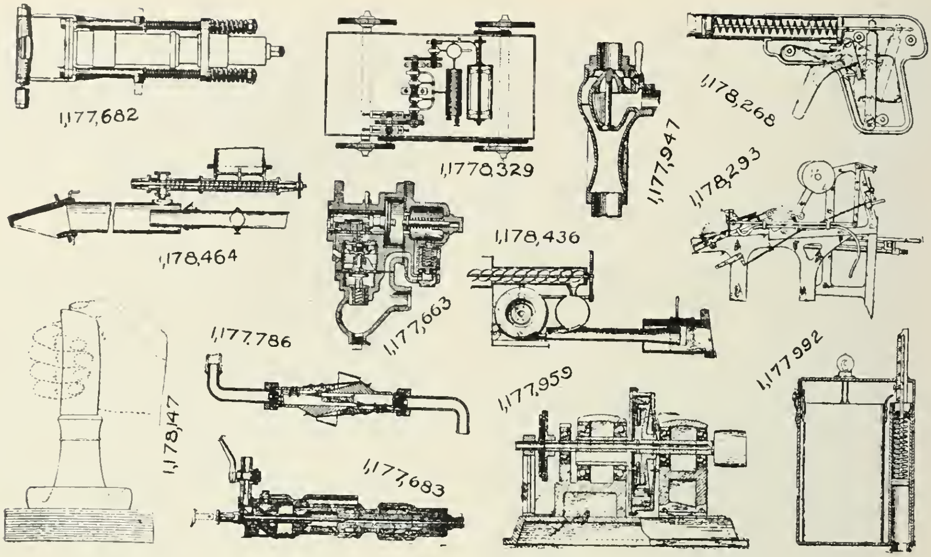
The Union Carbide Company, Niagara Falls, has started the erection of a large calcium carbide plant at Saude, about 60 miles from Bergen, Norway. The plant will buy its power from the Aktieselskabet Saude Faldene, and the power is to be furnished beginning Jan. 1, 1918. At first 20,000 hp. will be used. This will later be increased to 40,000 hp.

The steel industry is one industry in which for nearly ten years the only change in wages has been a movement upward. These advances have been as follows:

Jan. 1, 1907	7 per cent.
Jan. 16, 1910	6¼ per cent.
Feb. 1, 1913	10 per cent.
Feb. 1, 1916	10 per cent.
May 1, 1916	10 per cent.

As in each case the percentage of increase has been applied upon the rates in effect at the time, the total increase since Jan. 1, 1907, has been 43¼ per cent.—*Exchange.*

As we figure the above, the actual percentages added to the original 100 per cent. were, successively, 7, 6.69, 11.36, 12.5, and 13.75, making a total of 51.3 per cent., instead of 43¼.



Pneumatic Patents April 4.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 4.

1,177,663. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

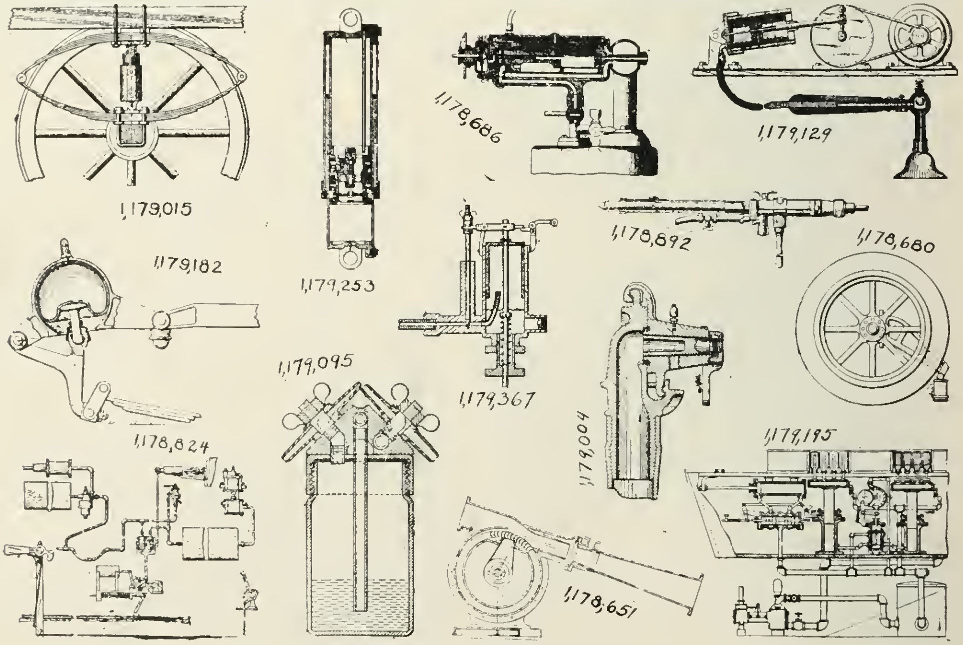
1,177,682. PNEUMATIC - TOOL HANDLE-MOUNTING. Omar E. Clark, Denver, Colo.

1,177,683. ROCK-DRILL. Omar E. Clark, Denver, Colo.

1,177,714. SUCTION-ERASER FOR BLACK BOARDS. George P. Lull, Bradford, Pa.

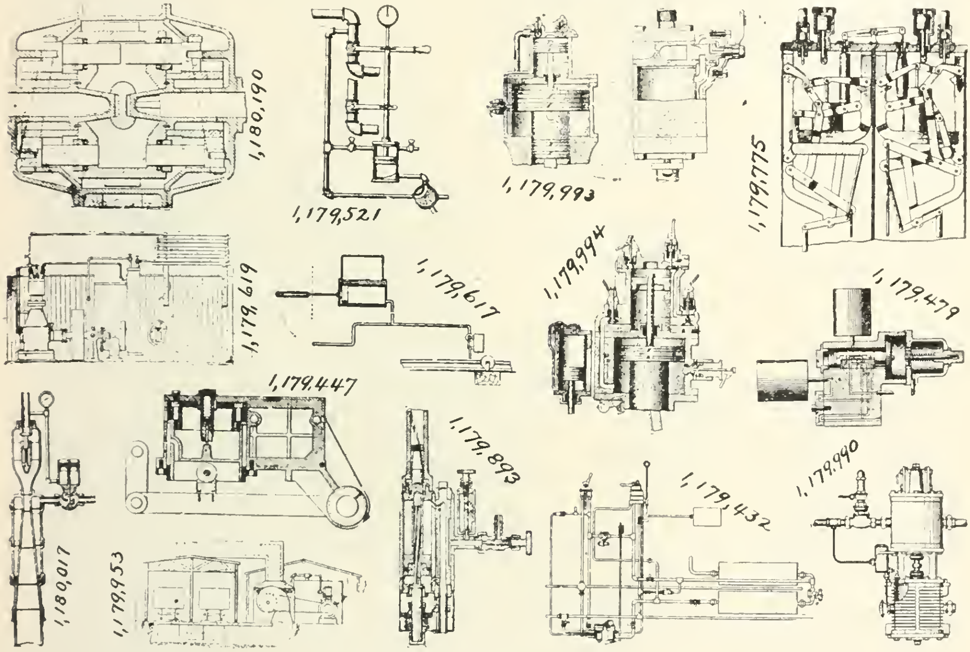
1,177,786. AUTOMATIC AIR-BRAKE COUPLING. George T. McMillan, Bushnell, S. D.

1,177,947. INJECTOR FOR VACUUM CLEANING AND OTHER PURPOSES. Edward R. Hangliter, Washington, D. C.



Pneumatic Patents April 11.

1,177,959. AIR-COMPRESSOR. George C. McFarlane, Denver, Colo.
1,177,992. PRESSURE GAGE OR INDICATOR. Charles A. Clouser, New Smyrna, Fla.
1,178,122. TIRE-PUMP. Louis A. Andrews, Newton Upper Falls, Mass.
1,178,147. VACUUM LIFTING DEVICE. James Gardner, College Hill Borough, Pa.
1,178,268. AIR AND POP GUN. William F. Schmidt, Detroit, Mich.
1,178,293. PNEUMATIC PILE-FEEDER. Georg Brandstetter, Hohenstadt, and Richard Freund, Vienna, Austria-Hungary.
1,178,329. PNEUMATIC SPRAYER. William A. McWilliams, Oakland, Cal.
1,178,436. FEEDING AND BURNING FINE FUEL. Walter D. Wood, New York, N. Y.
1,178,464. BURNING PULVERIZED FUEL. Henry R. Barnhurst, deceased, Catasauqua, Pa., by Henry G. Barnhurst, administrator, Catasauqua, Pa.



Pneumatic Patents April 18.

APRIL 11.

1,178,618. AIR-GOVERNOR AND EXPRESSION DEVICE FOR MUSICAL INSTRUMENTS. William F. Bayer, Buffalo, N. Y.
1,178,651. PUMP. Maurice Leblanc, Paris, France.
1,178,680. PNEUMATIC-TIRE-PROTECTIVE MAGNET. David Rosenthal, Boston, Mass.
1,178,686. AUTOMOBILE-TIRE PUMP. Frank C. H. Strasburger, Knox, Ind.
1,178,695-6. FLUID-MOTOR. Henry W. Yost, Springfield, Ohio.
1,178,703. PNEUMATICALLY-OPERATED ELECTRICAL SWITCH. Jacob F. Bentz and John A. Sertl, Schenectady, N. Y.
1,178,824. AUTOMATIC RAILWAY SAFETY APPLIANCE. Joseph F. Seibold and George H. Leppert, Jr., Indianapolis, Ind.
1,178,892. ROCK-DRILL. Daniel S. Waugh, Denver, Colo.
1,178,978. COMPRESSOR-VALVE. Charles Wainwright, Erie, Pa.
1,179,004. VALVE FOR RAILWAY AIR-BRAKE SYSTEMS. Abram Hall, Denver, Colo.
1,179,015. PNEUMATIC LOAD-COMPENSATOR FOR MOTOR-DRIVEN VEHICLES. John Thomas McCrosson, Honolulu, Hawaii.
1,179,095. PNEUMATIC SPRAYER OR AIR-BRUSH. Burton P. Hall, Fanwood, N. J.
1,179,129. SUCTION AND COMPRESSION CUPPING APARATUS. Joel A. Maxam, Idaho Springs, Colo.
1,179,182. PNEUMATIC SPRING FOR VEHICLES. Josef Hofmann, Baumaroche, Switzerland.
1,179,195. BOTTLE-WASHING APPARATUS. William Le Brocq, New York, N. Y.
1,179,253. FLUID-PRESSURE DEVICE. George Westinghouse, Pittsburgh, Pa.

1. A cushion device comprising a cylinder, a plunger fitted to slide within said cylinder to permit variations of the volumetric capacity thereof, a main packing for the sliding joint between the plunger and the cylinder, a supplemental packing for said joint on the low pressure side of said main packing, in combination with means for applying suction to the sliding joint between said packings.

1,179,367. AIR-MOISTENER. William Wyand, Absecon, N. J.

APRIL 18.

1,179,432. FLUID-PRESSURE BRAKE SYSTEM. James A. Hicks, Atlanta, Ga.
1,179,447. PNEUMATIC MEANS FOR MOUNTING CARRIAGES ON WHEELS. Henri Mercier, Paris, France.
1,179,479. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.
1,179,521. SPEED-CONTROLLING DEVICE. Hedley C. W. Graham, Rochester, N. Y.
1,179,526. PROCESS OF PRESERVING A CORPSE. Leonidas R. Houchens, Fairfax, Va.

The process of preserving a corpse which consists in placing the body in a permanent casket having a cover adapted to be hermetically sealed, sealing said cover, withdrawing the air from the casket, supplying antiseptic gas to replace the air, and then permanently sealing the casket.

1,179,582. PNEUMATIC FOR PLAYER-PIANOS. William T. Waite, Laporte, Ind.

1,179,617. TRAIN-CONTROLLING APPARATUS. Isaac P. Drawbaugh, De Queen, Ark.

1,179,619. COMPRESSOR. Paul R. Fowler and John A. Gingrich, Brownwood, Tex.

1,179,649. PNEUMATIC BED FOR LEATHER-WORKING MACHINES. Oscar Reirson, Peabody, Mass.

1,179,775. PNEUMATIC PUMP. Martin S. Swanstrom, Chicago, Ill.

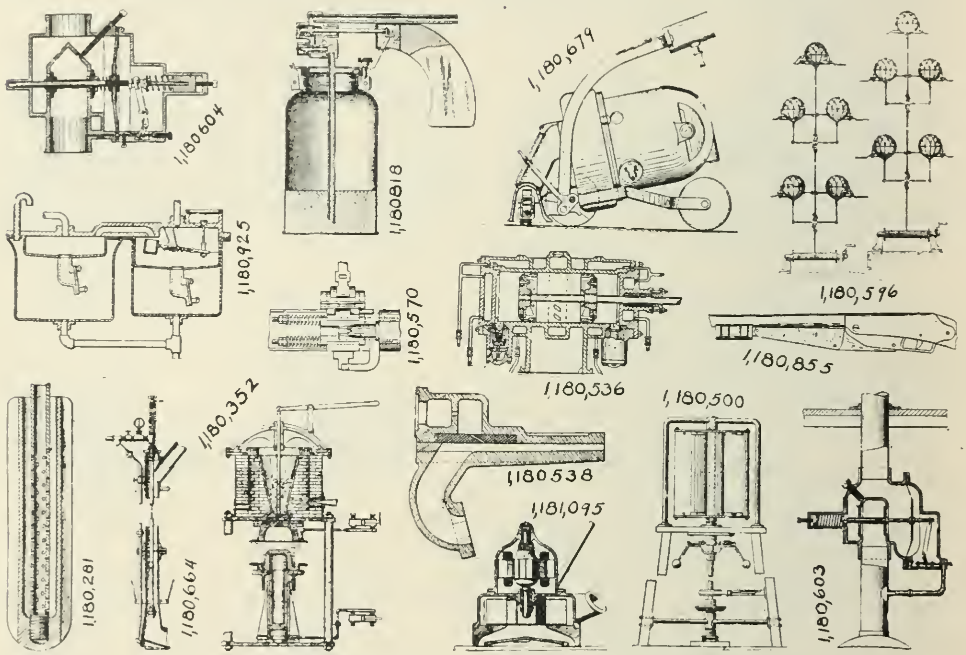
1,180,536. ICE-MACHINE COMPRESSOR. Henry D. Powell, Canton, Ohio.

1,180,538. LIQUID-FUEL BURNER. Charles Radiguer, St. Denis, France.

1,180,570. DRILL-SHARPENING MACHINE. Charles Christiansen, Gelsenkirchen, Germany.

1. In a drill sharpening machine, means for holding the drill, a pneumatically actuated matrix adapted to engage the cutting end of the drill, a yieldingly mounted forging-die inclosing said end movable in one direction by the matrix, and means to move said die against the action of the matrix.

1,180,596. AIR-MINES AGAINST ATTACK FROM AIR-CRAFT. Parcus McKinney, Los Angeles, Cal.



Pneumatic Patents April 25.

1,179,893. PNEUMATIC IMPLEMENTS. Myron F. Buckman, Seattle, Wash.

1,179,953. THAWING APPARATUS. Walter S. Newhall and Scott W. Linn, Cleveland, and Alva C. Hezlep, Miamisburg, Ohio.

1,179,990. LUBRICATOR FOR AIR-COMPRESSORS. Orville C. Wright, Fort Wayne, Ind.

1,179,993-4. FLUID PULSATING DEVICE. Albert Ball, Claremont, N. H.

1,180,017. VACUUM-JET. Thomas L. Davenport, Everett, Wash.

1,180,190. ROTARY PUMP AND BLOWER. James Robertson, Leytonstone, England.

APRIL 25.

1,180,281. AIR-LIFT PUMP. John R. Brown, Oil City, La.

1,180,352. VACUUM MOLDING - MACHINE. Conrad Werra, Waukesha, Wis.

1,180,355. AIR-OPERATED CHUCK. Lee M. White, Detroit, Mich.

1,180,430. AIR-THRUST PROPELLER FOR BOATS. Charles Edward Riedel, Detroit, Mich.

1,180,500. WIND-WHEEL. John W. Iley, Farmers Branch, Tex.

1,180,603. PNEUMATIC - DESPATCH - TUBE APPARATUS. Emmett B. Perrine, Chicago, Ill.

1,180,604. PRESSURE - ACTUATED PNEUMATIC TRANSMISSION APPARATUS. Emmett B. Perrine, Minneapolis, Minn.

1,180,664. PNEUMATIC PUMP-DREDGE. William J. Littlehales, Dickinson, N. D.

1,180,679. VACUUM - CLEANER. Arthur Thompson, Brookline, Mass.

1,180,744. PROCESS AND APPARATUS FOR SUPPLYING AIR AND OXYGEN OR THE LIKE TO INDEPENDENT DEEP-DIVING APPARATUS. Hermann Stelzner, Lubeck, Germany.

1,180,818. SPRAYING APPARATUS. Franklin F. Bradley, Chicago, Ill.

1,180,855. SPRING AIR-GUN. Charles F. Lefever, Plymouth, Mich.

1,180,871. PNEUMATIC ACTION FOR PIANOS. August Nordeen, Connersville, Ind.

1,180,925. LIQUID-ELEVATING DEVICE. Webb Jay, Chicago, Ill.

1,181,095. SUCTION-CLEANER. Joseph H. Templin, Philadelphia, Pa.

1,181,100. PNEUMATIC VEHICLE-WHEEL. Jacob H. Fawkes, Portland, Oreg.

4,55

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XXI JULY, 1916 No. 7

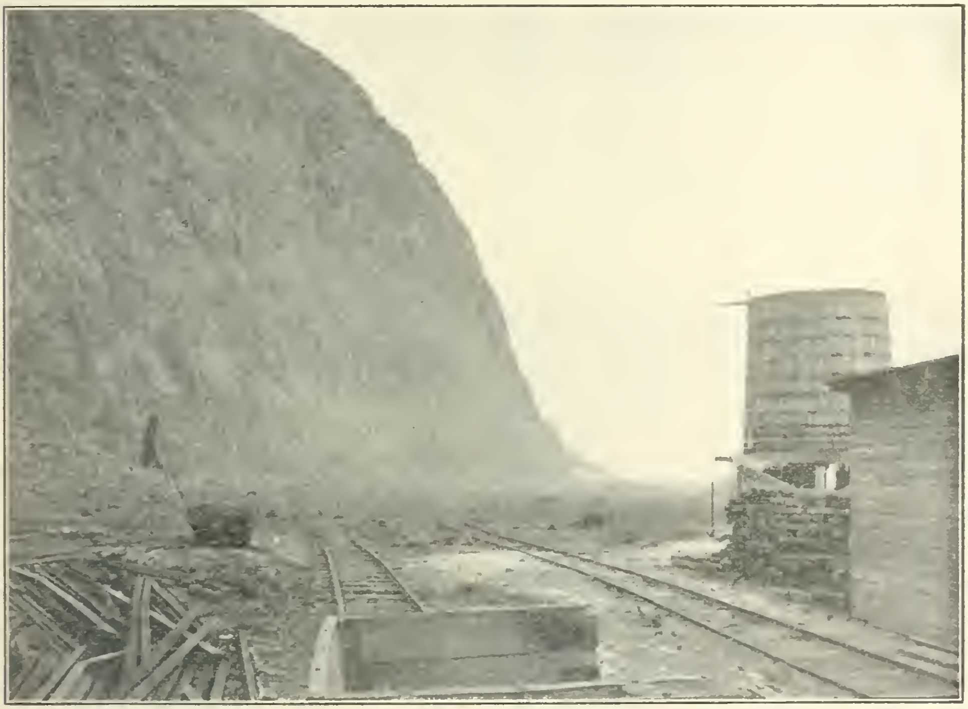


FIG. I. ROCKLAND LAKE TRAP-ROCK QUARRY.

COMPRESSED AIR AT ROCKLAND LAKE QUARRY

BY H. L. HICKS.

One of the largest trap-rock quarries in the United States is at Congers, N. Y., the Rockland Lake Quarry on the west bank of the Hudson River. Many improvements in plant and method of quarrying have been instituted here recently, and the New York Trap Rock Co., who now operate this property, began their second season with an enlarged crusher plant and a steam shovel loading equipment which has increased their output of crushed rock a third and has reduced the loading force to one-tenth.

Quarrying operations, which have been carried on here for 30 years, have "carved a slice out of the mountain" until the present working face is 540 ft. high at the center portion and about 3,000 ft. in length. The level quarry floor is 60 ft. above the river and about 400 ft. wide. The working day is limited by the light and is, at this reason from 6.30 a. m. to 5 p. m. The working force totals about 150 men, 30 of whom are engaged in loading rock at the quarry face. The daily output is about 4,000 cu. yd., an increase of 1,000 cu. yd. over last year's production. The crushed rock is loaded into the company's scows and delivered at any tidewater point.

The rock formation is a very hard, blue traprock, seamy and broken. A series of outwardly sloping cleavage planes, or, as the quarrymen call them, "faults," greatly facilitate the breaking off of large masses of rock with a minimum amount of drilling and blasting. In quarrying, the working face is kept as nearly vertical as possible (Fig. 2), so that the rock will fall at the foot of the cliff, without scattering.

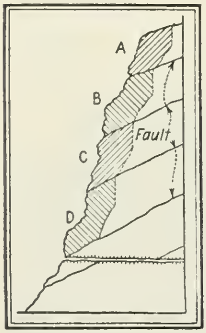


FIG. 2.

While it would seem that the drilling of blast holes on this precipitous quarry face would be an ideal job for a light weight Jackhamer drill, it has been found that to take full advantage of the natural cleavages, deep holes and heavier blasting charges are needed. This brings into use reciprocating piston drills, of which there are five at work.

There is very little earth overburden at the top of the cliff, and in many places the rock is exposed. To remove the upper layer of rock a row of 10 vertical holes about 30 feet apart are drilled 25 feet back from the face. These holes are 18 to 20 feet deep and are loaded with black powder and shot simultaneously. This blast causes a break to extend downward to the first cleavage plane. The force of the explosion tends to throw out the large mass of rock "A" (Fig. 2), while the slope of the natural cleavage line permits it to slide off easily and fall to the bottom of the cliff. The second step in working downward is the drilling of holes on the ledge thus formed. The face of the quarry becomes very irregular and, therefore, it is impracticable to drill these holes in rows. Two or three holes are put in wherever the most rock can be gotten out with the least powder. These odd groups of holes are of about the same depth as the first row and in blasting break to a second "fault." This method is repeated, bringing down successively "B," "C," etc., until the bottom is reached.

When drilling on the ledges it is usually necessary to drive a couple of pegs and fix a plank to hold the drilling machine, steels, etc. The holes for these pegs are often drilled with Jackhamers, as a man can easily handle one of these drills on a very scanty footing. In starting such holes the drill runner descends from the top, taking particular pains to dislodge any fragments of rock which might become loosened while he is at work below.

The deep blast holes are started with 3¼-in. bits and bottom at 1¾ inches—10 changes of steel. Cross bits are used for all this work. The drilling machines and steels are hoisted from the quarry floor up one of several inclined ropeways and lowered or swung into position. This hoisting is done by horses—or by one of the "dinkies" when it is handy.

The drilled blast holes are sprung or "squibbed" with about 25 pounds of dynamite, both to enlarge the cavity for the powder charge and to start lateral cracks into which the powder can be worked, so as to spread the blasting force. "Squibbing" is often repeated when the first charge does not develop a decided cleavage crack. Under favorable conditions and with careful spreading of the powder the rock will break from 15 to 20 feet either side of the drill holes. The black powder blasting charge varies with the character of the rock, 300 pounds being considered a heavy charge for a difficult break.

The rock shatters well in falling, but blockholing of the larger "chunks" is necessary This work keeps seven Jackhamers (Fig. 3), busy, putting in holes averaging 2 feet deep, although at times steels up to 7 feet are needed.

For this work the drill bits used are the "Carr" type, this having been tested and proved to be, in this hard rock, about 50 per cent faster than the 6 point rose bit formerly used. The Jackhamers average from 100 to 200 holes per day. The holes are loaded with 60 per cent. Du Pont dynamite and fired with fuses. The

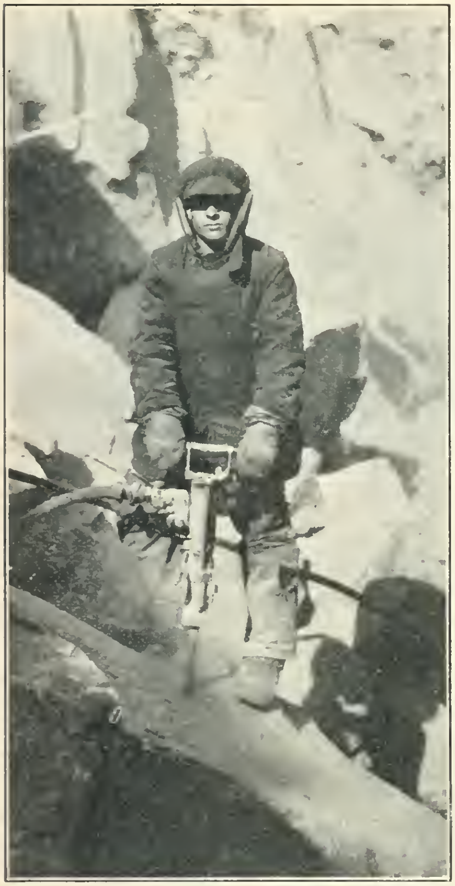


FIG. 3.

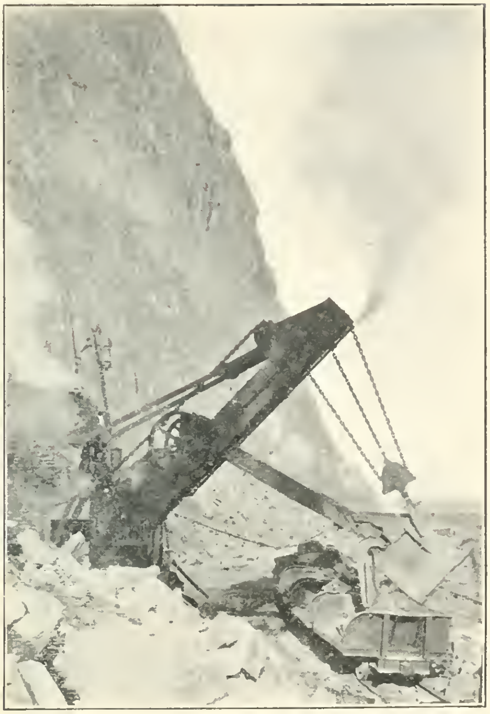


FIG. 4.

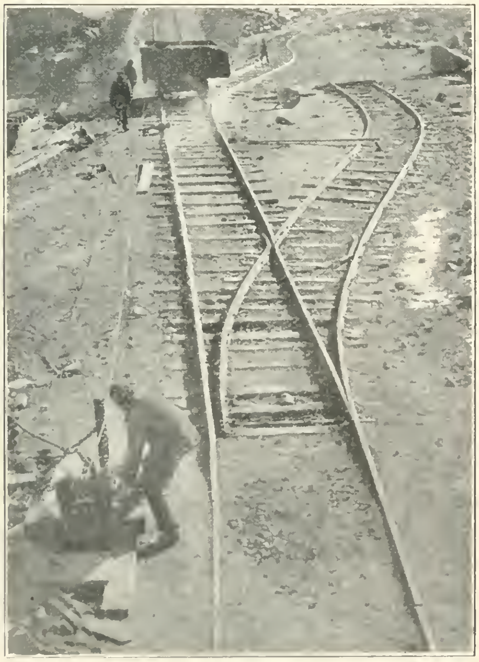


FIG. 5.

cost of dynamite for block-holing is now less than $.001 per yard of total output.

Shooting of both blast holes and block-holes is done at noon and night—preferably night—although a few block-holes are often shot at odd times to prevent delay in loading.

The loading equipment consists of two Bucyrus 110C (4 yard) steam shovels loading into open side steel cars. These shovels are said to be the most powerful machines at work in this part of the country.

There are 30 cars, handled in strings of 5 by three "dinky" locomotives.

Loaded cars are delivered by the locomotives to an inclined cableway where they are hauled up into the crusher house (Fig. 3), and dumped directly into the crusher. From here they coast down an incline and up a slight grade toward the upper end of the quarry, where they are switched over and run by gravity, back parallel with the quarry face. It frequently happens that a car or two cars will not carry past the switch, and to keep the cars in motion a Little Tugger (Ingersoll-Rand), has been bolted to a timber at the extreme end of the track (Fig. 3). This hoist is of the small air operated type originally developed for winze hoisting in mines. When needed this machine hauls two 6½-ton cars up this 6 per cent. grade without any trouble. Fig. 4 shows the remarkably compact construction of this machine. Its weight is only 185 pounds.

The crushing equipment consists of a large 72-in. by 84-in. Taylor Jaw Crusher, 2 8-in. and 8 6-in. Gates Gyratory Crushers and a 72-in. Traylor Roll. These deliver the crushed rock directly to the bins, from which the scows are loaded.

The drill sharpening and blacksmith work is divided between two men. One sharpens the piston drill steels and does the general work and the other operates a No. 5 Leyner Drill Sharpener. This machine is used for forging bits and shanks and resharpening the Jackhamer steels.

The power equipment at the Rockland Lake Quarry is divided between two power houses, the one being a part of the crusher plant and the other a new building at the lower end of the quarry. In the first are installed 4 16-ft. by 72-in. tubular boilers, a 28 by 48 Wright engine, a low pressure Allis-Chalmers turbo-generator, a turbo lighting set, a Wheeler surface condenser and the necessary auxiliaries. Here is also a small air compressor which is held for emergency use. The low pressure turbo-generator is operating on exhaust steam at 1 pound pressure, which the master mechanic says "is as good as finding the power."

The lower power house contains the main air compressing unit an Imperial Corliss steam driven machine of 2,400 cu. ft. capacity, a Westinghouse high pressure turbo-generator, surface condenser and auxiliaries.

The compressor has for an air receiver a horizontal steam boiler placed directly outside the building. From this an 8 in. air line leads to the quarry floor, where two 6 in. branches extend in either direction along the quarry. These air lines are buried to prevent damage from flying rock, and are provided with branch connections at intervals. Air is carried along the top of the quarry by a 2 in. air line, maintaining a pressure of 80 lb. at the drills. In cold weather the air is heated by a crude device, open log fires being maintained under the branch air piping near the point of use.

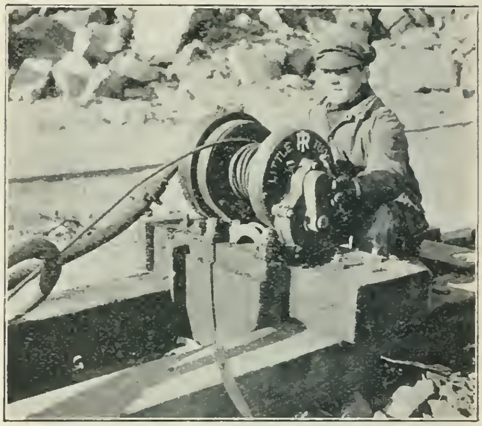


FIG. 6.

Water for the boiler plants, the shovels and locomotives is pumped by an air lift from a 160 ft. well, this supply being maintained with practically no attention and at low cost. For condensing purposes the slightly salt river water is used.

The pumping of the water is only one of the extra uses to which the air is put. The blacksmith uses it to blow his fire, the Little Tugger hauls cars by air power and the workmen in building a scow (on contract), used air for operating wood borers and a hoisting engine This latter was normally a steam machine with the intermittent operation, totalling at the most an hour of continuous use per day, was found to operate more economically with air than with steam.

BLASTING FOR CLAMS

One of the strangest creatures known to science is the pholas, or boring clam. When still very minute the animal bores into the sandstone ledges at extreme low water, by means of its sharp shell, which is replaced by secretions as it is worn away. It penetrates the rock to a depth of six or eight inches and hollows out its burrows as it increases in size. Shaped roughly like a top, it could not leave its rock dwelling even if it wished to do so. For food it depends on the animalcules that float on the sea water, which it seizes by its long siphon, or tongue. The pholas is in demand at the seaside resorts along the Pacific coast, for its meat is very tender and makes excellent soup. The clams are dislodged in great numbers from the ledges by the use of dynamite, although it is possible to obtain them with a pick or crowbar.

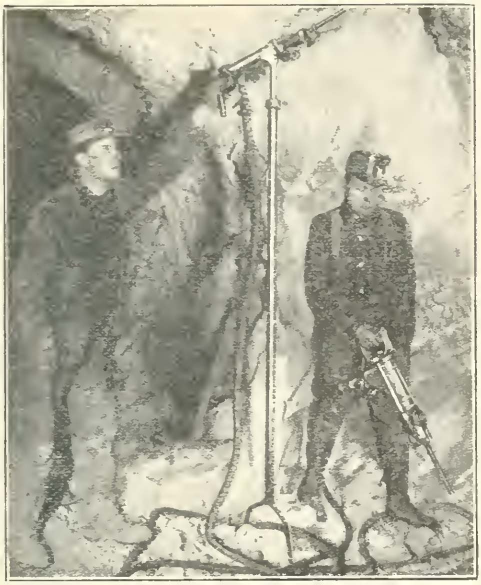
ENLARGING A WORKING TUNNEL IN ALASKA JUNEAU MINE

BY JOHN RICHARDS.

The cutting of the drainage ditch in the Gold Creek tunnel, the 6,500-ft. working adit into the Alaska Juneau mine, was postponed until the tunnel was completed. The ditch when started was $1\frac{1}{2}$x$1\frac{1}{2}$ ft. and ran along the left-hand side of the tunnel. This work was started in July, 1914, with all drilling being done by hand. The difficulty with the ordinary machines working on a column or bar, in this work, was that the tunnel had to be kept open for haulage at all times. This prevented the use of a rigid set-up as the train might come at any time and necessitate the removal of the bar. After two months of hand drilling, however, the Ingersoll-Rand jackhamers were started on the work. The size of the ditch was increased 2x2 ft. at the time the jackhamers were introduced. A summary of the drilled were not obtained on account of the work month by month shows that the average cost of labor per foot when drilling by hand was $1.36, and when using jackhamers it was $0.42. The data on running times and footage intermittent character of the work. Drilling and mucking were done by the same crew, and it was necessary to so arrange the work that the train service would not be interrupted.

A NOVEL PORTABLE JACKHAMER MOUNTING.

In conjunction with digging the ditch, the tunnel, originally of 7x9-ft. cross-section, was straightened and widened to a minimum of 8 ft. In many places the roof was low and this too was taken down. The drilling for this work was done by the jackhamers, the depth of holes drilled varying from 1 to 7 ft. In taking down the roof, a portable mounting, designed in the Alaska Juneau shops, was used to hold the machine in place. This mounting, shown in the accompanying illustration, consists of a short length of 1-in. pipe terminating at its upper end in a small fork which fits around the cylinder of the drill, and its lower end, sliding inside a $1\frac{1}{4}$-in. pipe with a collar and set screw at its upper end which make possible the adjustment of the fork at any height. At the lower end of the larger pipe, which is about $4\frac{1}{2}$ ft. long, is a larger fork, spreading about 16 in. at the lower points. This fork rests on the ground and gives the whole mounting stability.



NOVEL MOUNTING FOR JACKHAMER.

When using this mounting in drilling, the lower fork is placed slightly forward, giving the mounting a backward slant when starting the hole. As the hole deepens, the mounting becomes vertical and then is inclined to the front. From time to time the upper fork is raised and adjusted by the set screw in order to keep the machine in line.

The chief advantage of the jackhamer in this work was its portability and its ability to drill while so close to the wall or roof, requiring a minimum inclination for the hole and hence a minimum amount of rock broken for the gain made in height or width, and allowing also, longer holes to be drilled.

AIR LENSES FOR DIVERS' SPECTACLES

The indistinct appearance which objects have to human eyes when the eyes are submerged and in contact with water is well known to swimmers and divers. Spectacles have been produced by a European firm which overcome this difficulty, making other eye protection unnecessary. Objects appear indistinct to eyes submerged in water because the human eye is designed to focus light rays entering it from the air; rays entering the eye directly from water are not properly refracted, and lack of definition is the result. The new spectacles have large hollow lenses, the outer walls of which are plane and the inner walls concave of practically the same curvature as the cornea, an air-tight chamber being in between. With these spectacles a diver has an air chamber always before his eyes and so sees normally. The glasses are fitted with pneumatic rubber rings which are adjusted tightly around each eye, making a chamber between the eye and the lens which is filled with water. Fresh water may be used if the diver is to descend into water so salty that it would be injurious to the eyes. This film of water is very thin, and, having parallel surfaces, does not appreciably refract the light rays, which therefore reach the eyes as if coming from air.—*Popular Mechanics.*

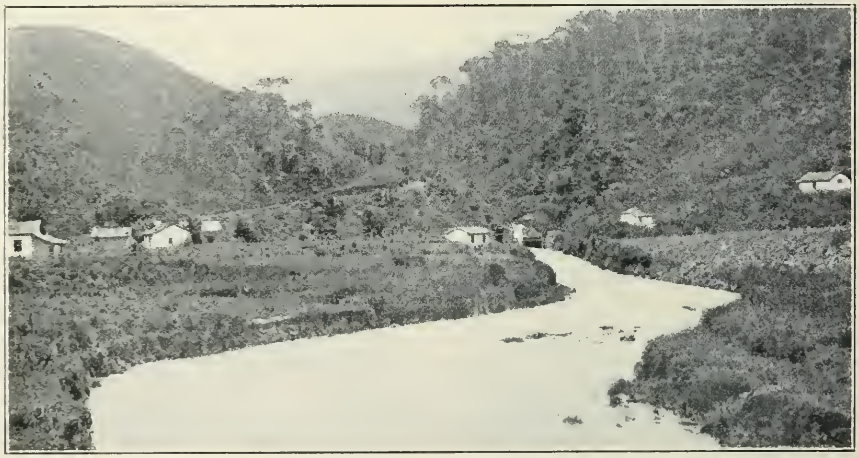


FIG. I. DISCHARGE FROM PIRAHY TUNNEL.

A REMARKABLE TUNNEL RAPIDLY DRIVEN IN BRAZIL

The following account by Mr. J. C. Balcomb, of the Pearson Engineering Corporation, 115 Broadway, N. Y. City, we condense from a recent issue of *Engineering News*. It will appear that the methods and resources of the modern engineer are now equally available all over the earth, so that what is worth noting concerning the Pirahy tunnel here spoken of and the construction of it is in the work itself much more than in the location.

The City of Rio de Janeiro, with a population of over 1,000,000, is supplied with all electric current for light, power and local transportation by the Rio de Janeiro Tramway, Light and Power Co., Ltd., a Canadian Corporation. A hydro-electric plant at Lages, about 50 miles west of the city, is the principal source of power. A succession of dry seasons and an increased demand for electricity compelled the immediate installation of an auxiliary steam plant the cost of operating which amounted to several thousand dollars a day. This enormous expense rendered an additional water supply imperative and the 5¼ mile Pirahy tunnel was designed to divert the Pirahy River into the Lages reservoir.

It will be easily understood that speed was imperative, and so this tunnel 27,657 ft. from portal to portal was completed in 489 days, or say a year and four months, the best single-face monthly record being 512 ft.

The tunnel was bored under three hills, as shown on the accompanying profile, the two end elevations being divides and the center one a round knob. The work was attacked at ten faces by means of four shafts and two portals. One shaft was located very close to the outlet end; therefore, the progress was actually made from eight working faces.

Construction began on approach cuts Nov. 1, 1911, and water was turned into the tunnel on Sept. 28, 1913, an interval of not quite 23 months. The advance heading, 13 ft. wide by 8 ft. high, was probably one of the largest ever driven. It was justified by the expecta-

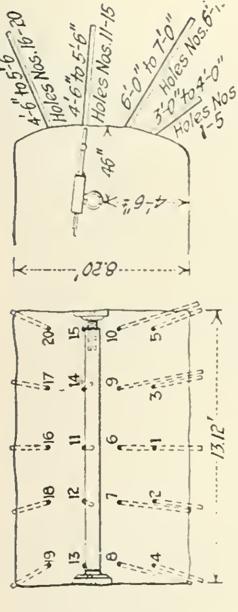
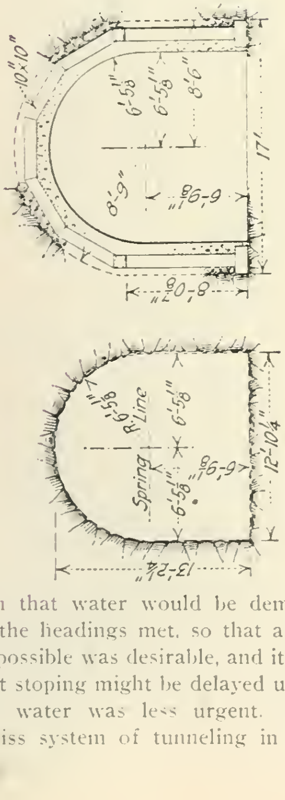

4'-6" to 5'-6" Holes Nos. 16-20
4'-6" to 5'-6" Holes Nos. 11-15
6'-0" to 7'-0" Holes Nos. 6-10
3'-0" to 4'-0" Holes Nos. 1-5
46"
4'-6"
8.20'
13.12'

FIG. 3. DIAGRAM SHOWING ADVANCE METHOD
Holes usually fired in rotation shown by numbers



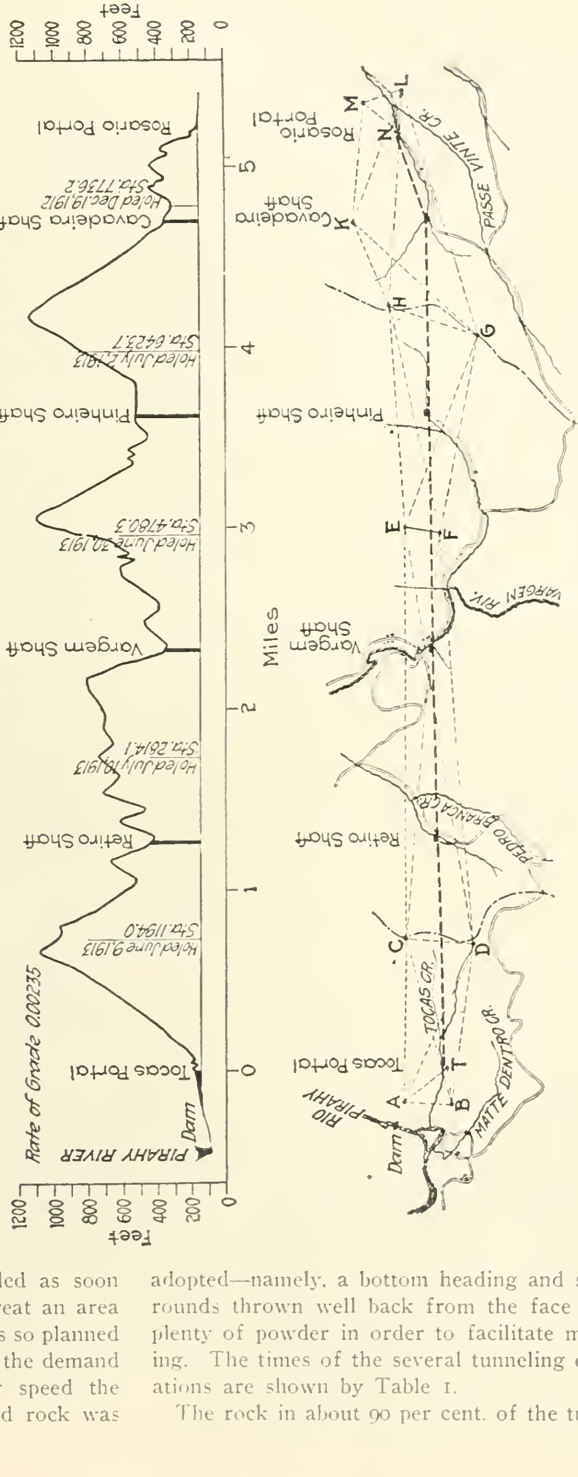


FIG. 2. PLAN, PROFILE AND SECTIONS OF PIRAHY TUNNEL

tion that water would be demanded as soon as the headings met, so that as great an area as possible was desirable, and it was so planned that stoping might be delayed until the demand for water was less urgent. For speed the Swiss system of tunneling in hard rock was adopted—namely, a bottom heading and short rounds thrown well back from the face with plenty of powder in order to facilitate mucking. The times of the several tunneling operations are shown by Table 1.

The rock in about 90 per cent. of the tunnel was solid gray gneiss of constantly changing character and very seamy and fractious; the rest of the material was either decomposed trap, necessitating timbering, or strata of extremely hard diabase. Only about 1,000 ft. of the tunnel had to be lined. Water was struck in every advance, and pumps were maintained at all shafts and the upper portal end.

Five Ingersoll-Rand 3¼-in. piston drills were used in each face, and it was the endeavor to supply them with air at 95 to 105 lb. The first bit was a 2⅜-in., the second 2⅛-in., the third 1⅞-in., the fourth 1⅝. The powder sticks were 1¼x7 in. A great deal of time was lost on account of inability to get spare parts, and the full economy of the machines was seldom realized. These five drills were supported on an 8-in. horizontal column 12 ft. long, which in turn was taken to and removed from the face by a Carter tunnel carriage. This apparatus consists of a small truck supporting a beam that projects to the front over the pile of muck, and a mechanism to propel the 8-in. horizontal column back and forth along the beam. After a blast the track was cleared of débris to within about 16 ft. of the face, the carriage was pushed forward as far as possible and the head end of the beam blocked up on the muck pile. The horizontal column that supported the five machines was then run forward to within about 4 ft. of the face and there jacked securely to the sidewalls. When firmly in position, it was released from the beam, and the carriage was taken back into the tunnel and stored on a spur track, where it remained out of the way until drilling was completed.

TABLE I. TIME OF PIRAHY TUNNELING OPERATIONS.

General Averages of Faces, Based on 7 Months' Progress.

Setting up drills (including "barring down" roof, cleaning track, blocking column and time lost for smoke)	1 hr. 43 min.
Drilling	4 hr. 40 min.
Taking down drills	20 min.
Blasting (including loading)	58 min.
Average time between shots	7 hr. 41 min.

The number of men actually employed at the working face averaged about as follows: 1 face foreman, 1 muck foreman, 6 drill runners, 6 drill helpers, 22 muckers, 1 extra drill runner and helper to insure full service of machines every shift. Muckers include car pushers and laborers pulling back rock from face. Labor mostly Spanish; three 8-hr. working shifts.

Averages Based on Best Week's Work (Pinheiro, April 16-22)

Setting up drills (including "barring down" roof, cleaning track, blocking column and time lost for smoke)	1 hr. 8 min.
Drilling	3 hr. 46 min.
Taking down drills	14 min.
Blasting (including loading)	33 min.
Number of holes	20
Depth of holes	1.5 m.
Dynamite, 92% blasting gelatin	99 sticks
Dynamite, 62% gelignite	138 sticks
Average time between shots	5 hr. 41 min.
Total advance (7 days 2½ hr.)	41 m. = 134½ ft.
Average daily advance	5.77 m. = 18.93 ft.
Average advance per shot	1.37 m. = 4.49 ft.
Number of blasts in week	30
Dynamite per cubic meter	8.4 lb. = 6.48 lb. per cu. yd.
Material	Uniform gray gneiss, flat roof—no timber.

The advantages derived from the use of the tunnel carriage were that it saved the time necessary to muck back from the face for vertical columns; it saved the men the heavy lifting and tugging of the drills and vertical columns over the muck; and it gave the muckers a clear space to muck out under the column, as the drill runners could stand upon it to crank their machines. The method of drilling, the depth and position of drill holes and the rotation of shooting are shown in Fig. 3.

UNUSUAL BLASTING METHODS.

After the completion of drilling, the holes were cleaned with compressed air by a nozzle on the air hose and afterward nearly filled with gelignite, or blasting gelatin, ranging in strength from 62% to 92%. Very little tamping was done other than stuffing in a few pieces of dampened cardboard that came wrapped around the powder. Only the very highest grade of fuse, every foot of which was guaranteed by the manufacturers to be X-rayed, was used; this was cut into equal lengths and properly prepared with detonators, etc., above ground. (No. 8 detonators were used exclusively after numerous failures with No. 4 and No. 6.)

When the holes were all loaded and the fuse tamped in, the round was made ready to fire in the following manner: The five top fuses in holes Nos. 16 to 20 inclusive (Fig. 3) were left full length; beginning with No. 15 a short length was cut off, and the length of the piece thus cut was gradually increased in each succeeding hole until the first hole to be shot (No. 1) remained with the shortest fuse. A foreman would then peel back the paper on a stick of gelignite, ignite it and use it to "spit" the fuses, beginning with hole No. 1 and finishing with any one of the top holes.

The deliberation with which the Spanish foremen performed this task was almost uncanny; but it was very successful, as it left a distinct interval between each shot and the workmen soon learned to locate the missed hole accurately by a too long lapse of time. A second shot to clear away a bump left by a missed fire was rarely necessary; it usually saved much time to wait and remove these later with Jackhamers and light shots from behind. The men became expert at this style of shooting, and a great deal of the speed attained was attributable to the system. Such a method is contrary to almost any state law in the United States as being too dangerous, but its justification in this case lies in the fact that in the thousands of rounds fired by this method on the Pirahy tunnel there was not a single accident from that cause. After the round had been fired and a reasonable time had been allowed for any missed shots (but without waiting for smoke to clear), the machine runners and helpers went in to bar down the roof and clear the face, while the muckers followed and cleared the track for the tunnel carriage.

As in most tunnels, the progress was limited pirncipally by the ability to get the muck out of the way. To hasten this work, the double-shift system was used. The muck car was brought in by car pushers, and the box was thrown to one side of the track and the truck to the other, a little way back of the face. The resting shift kept an eye on the loaders at the front, and when their car was nearly full, the former got ready to throw truck and car body on the track as soon as the loaded car was pushed by. Very little time thus elapsed when cars were not being actually loaded.

During a record week, cars were loaded and taken out at the rate of a car every 4 min.; the general average under fair conditions was about 6½ to 7 min. to each. Under ordinary circumstances it was found that by keeping plenty of men to rake back the muck from the front and under the column the muckers could get the material out of the way and do all necessary track laying as soon as the drilling was finished and be ready to help the machinemen take down the column, etc.

BONUS SYSTEM OF WAGES.

To encourage the men to take a personal interest in the progress, a unique bonus system was adopted. A minimum month's work was made 75 lin.m., and the bonus began above that figure; for every meter in excess of 75 m. and up to 90 m. the men were given 75 milreis, or about $24.20, per lineal meter. For everything over 90 m. a month, 150 milreis, or about $48.40, per meter was granted. In the record month there was distributed something over $3,550 among 135 men at one face. This bonus was distributed to the men in proportion to the wages received by them at the end of the month. All men known as "smoke eaters," who actually did the hard and sometimes dangerous work at the face, participated in this bonus in proportion to the full amount of their wages; other men helping the progress more indirectly, such as car pushers, cage tenders, steel sharpeners, etc., shared in the bonus in a proportion of from one-quarter to one-half of their wages, the idea being not only to make it an object for the best men to strive to get to the most essential part of the work, but to keep all men interested in the progress. Probably one of the greatest advantages of this bonus was that it automatically kept the gangs at a minimum number—the more men the less bonus to each and *vice versa*. Also, the men themselves made it convenient for a loafer to quit.

This bonus system worked splendidly throughout the job, and more than any other one thing it was responsible for the great progress made. The disadvantage of this plan, as of any other bonus system, was that it tended to make the men careless, safety and all other considerations being neglected to gain a few meters. The foremen in all instances had to see personally that the men barred down the roof properly and took no unnecessary chances.

It may be interesting to mention here that 200 tunnel laborers and their foremen from the New York subway work were sent down to the Pirahy tunnel to show the Spaniards "how to do it." Most of the Americans turned round and went back north on the same boat that they arrived on. The few who remained were disinclined to work with the horizontal column and preferred the vertical-column method, where the face must be cleared first, losing much time thereby; they refused to use any but electric exploders in blasting and would not go into the smoke like the Spaniards. Furthermore, the American machine runners would not help muck back and assist the progress, as did the Spanish machine runners. This experiment decided for us, at any rate, that American laborers cannot or will not successfully put up with labor conditions as they are met with in Brazil.

After the headings had all met and water had been allowed to run through the tunnel for a few days, it was endeavored to stope during 10 hr. in the daytime and permit the water to run through at night. It was speedily discovered, however, that this was impracticable, as it took several hours for the tunnel to drain, and the proportion of lost time was out of reason. Therefore, the whole force was put to stoping 24 hr. a day, using telescopic drills for stoping, jackhamers for trimming and 52% gelignite for blasting; the record made is shown in Table 1.

When any timbering was necessary, it was found desirable and economical to import timber for that purpose from the United States. The native lumber was principally hardwood, extremely difficult to tool and too heavy to handle economically, particularly in segment work. The Parana pine from southern Brazil was too brash and totally unfit to withstand any great stress. Therefore, practically all timbering except lagging was done with North American pine.

ALLIED WORKS OF PIRAHY TUNNEL.

Across the Pirahy River near the inlet of the tunnel was built a concrete dam of the overflow gravity type. This dam was for diversion only, and the construction involved no unusual difficulties except the ever-present problem of transportation of materials in such a country. It impounded practically no storage water. The flow into the tunnel was controlled by four electrically operated rectangular valve gates each 5x16 ft. These are closed only at rare intervals, when inspection of the tunnel is considered necessary.

About midway of the tunnel and traversing the surface is a small stream called the Vargem River. As there was a shaft at this point, it was decided to utilize this water for storage by diverting it into the tunnel by way of the shaft. It is obvious that, were this water dropped perpendicularly down the shaft, the disturbance created at the bottom would have a retarding effect on the main stream passing; it is equally apparent that if the force of water dropping 200 ft. was properly directed and the force expended in the right direction, it should have an accelerating effect upon the main current of water in the tunnel. So with this in view the water from the Vargem was guided into the tunnel at the foot of the shaft by a reinforced-concrete tube colloquially known as the "snout." This was so constructed (Fig. 4) that the falling water was diverted from a vertical to a horizontal flow down the tunnel by an approximate parabolic curve and at the same time thrown sidewise enough to enter the main stream at a small angle (the shaft proper being situated at the side of the tunnel).

It was almost impossible to make any actual observations or calculations of the effect of the entrance of this water at the foot of the shaft, but it was discovered that it was an extremely hard matter to build a floor there which would withstand the heavy impact of the falling water. The writer had himself lowered with ropes into the tunnel stream one time and observed the action for some minutes, and

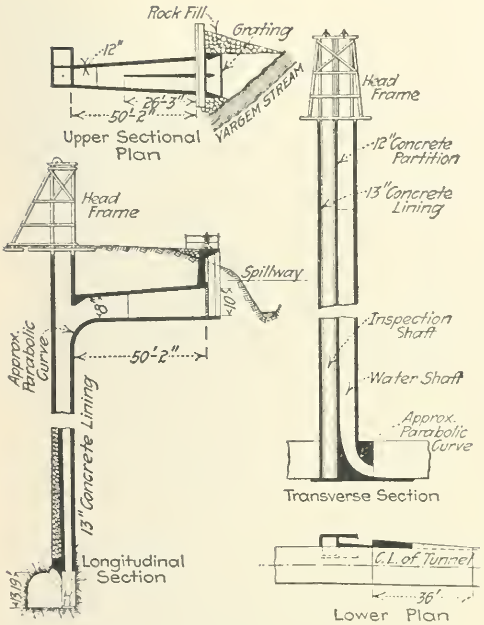


FIG. 4.

from these and subsequent observations it is believed that the falling water actually assists the velocity of the main stream to some extent when the tunnel is running full, as there is no apparent disturbance. When running only half full, the commotion is so great that there must be some slight retardation.

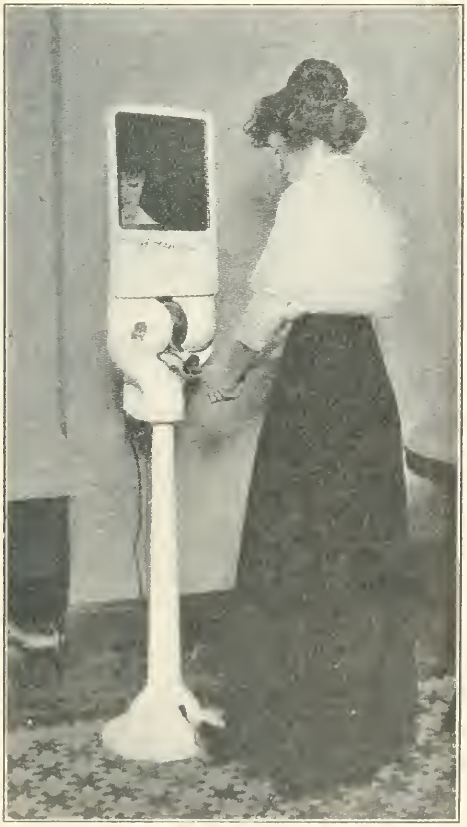
The tunnel was constructed by administration by the Rio de Janeiro Tramway, Light and Power Co., Ltd., of which W. G. McConnel was Chief Engineer until 1913; the late D. H. Campbell was Superintendent, and to him were primarily due the efficient organization and the splendid progress made. The writer was first Chief Engineer of the tunnel, later Assistant Superintendent and eventually Chief Engineer of the Company.

"NOTOWL" FOR DRYING FACE AND HANDS

We have previously mentioned the use of currents of air for drying the hands after washing them. A very complete electrically operated apparatus, called "Notowl," has been devised for this service and we may expect to see it coming into general use. The half tone on this page showing a complete equipment is reproduced by the courtesy of The Edison Monthly. There is a horn for delivering the air which may be set at any convenient height for the hands and can also be lifted to be passed all over the face, and it would also be of service for those who indulge in the foolish practice of washing the hair.

This apparatus not only supplies the necessary flow of air but also heats the air to make it more effective. On pressing with the foot on the lever at the base, air is drawn into the column by a suction fan through the small opening which is seen above the lever. The heating element is in the hood, encasing the air passage for a short distance with incandescent wires. After the machine is set going the heated air is almost immediately forthcoming in liberal volume.

Rated at 11 amperes, the "Notowl" consumes 1,200 watts per hour if it runs continuously, which of course it does not. The cost of operation and maintenance is said to be not more than a quarter of that required for keeping up a decent supply of towels.



"NOTOWL."

ATMOSPHERIC HUMIDITY AND ITS MEASUREMENT

BY KENNETH G. SMITH.*

According to the Law of Partial Pressures, commonly known as Dalton's Law, two gases at the same temperature do not interfere with each other's pressures when mixed, provided there is no chemical action. Each one exerts the same pressure that it would at the given temperature if the other were not present. The total pressure is the sum of the pressures of the two gases. Experiment shows that this law holds good for a mixture of gas and vapor such as water vapor and air. Taking water vapor and air as an example, if Pa is the air pressure and Po the vapor pressure, than $Pa - Po = Pt$ = total pressure of vapor and air. If the vapor is saturated, the temperature of the mixture is definitely fixed at the saturation temperature corresponding to the pressure Pt. If the temperature is higher than the saturation temperature at the given pressure, the vapor is superheated. Water vapor in the atmosphere is superheated except on damp, foggy days, when the water vapor is saturated, or as we say, the air is saturated with moisture.

The weight of a cubic foot of superheated vapor is less than the weight of a cubic foot of saturated vapor. If m_1 is the weight of a cubic foot of saturated vapor and m_2 = weight of a cubic foot of superheated vapor at the same temperature, then the ratio $\frac{m_2}{m_1}$ expressed in per cent. is called the humidity of the air containing the vapor. That is, it is the ratio of the moisture actually contained in the air to that which the air could contain at that temperature if saturated.

If a mixture of air and superheated vapor is cooled at constant pressure (say atmospheric pressure), it will finally reach a point where the vapor becomes saturated instead of superheated and further cooling results in condensation. The temperature at which condensation begins is called the dew point. This is simply the saturation temperature for the given pressure. The gas law PV = constant, which we may assume holds good for low vapor pressures, gives us the means of calculating the ratio $\frac{m_2}{m_1}$ already referred to as the humidity.

Let P_1V_1 represent the condition of saturated vapor at the given temperature and P_2V_2 its actual condition at this temperature—that is, in its superheated state. Then

$$P_2V_2 = P_1V_1 \text{ and } \frac{P_2}{P_1} = \frac{V_1}{V_2}$$

If the vapor is cooled at a constant pressure P_2 down to the saturation temperature—that is, to the dew point—then since P_2 is unchanged the ratio $\frac{P_2}{P_1} = \frac{V_1}{V_2}$ still holds good; now substituting for the volumes per cubic foot, their reciprocals, the weights per cubic foot, $\frac{P_2}{P_1} = \frac{m_2}{m_1}$.

Hence, the humidity in per cent. is equal to the ratio of the pressure corresponding to the dew point to the saturation pressure corresponding to the temperature of the mixture. An example will make this method of measuring humidity clear. Suppose that air has a temperature of 70 deg. and the dew point is found to be 50 deg. What are the humidity and weight of vapor per cubic foot? From a table of vapor pressure we find that at 55 deg. the saturation pressure is 0.436 in. of mercury. At 75 deg. the saturation pressure is 0.8735 in. of mercury. The humidity is then $\frac{0.436}{0.8735}$ = 50 per cent., very nearly. If the air were saturated at 75 deg., it would contain 9.36 grains of moisture per cubic foot. Hence, at 50-per cent. saturation it contains $9.36 \times 0.5 = 4.68$ grains per cubic foot.

To measure moisture in this way would be difficult under other than laboratory conditions, and for that reason another method, using a wet- and a dry-bulb thermometer, has been adopted. The dry-bulb thermometer is simply an ordinary Fahrenheit thermometer. The wet-bulb instrument is exactly the same except that it has a piece of muslin or other porous material wrapped around the bulb and saturated with water. When both are exposed to the air, the wet-bulb thermometer immediately falls to a lower temperature than the other, owing to the fact that the evaporation of the moisture in the cloth requires heat. The drier the air the more the evaporation and the greater the drop in temperature. From the difference in temperature between the wet- and dry-bulb thermometers the humidity may be calculated. In practice it is not calculated, but read directly from a table or curve.

---

*Professor engineering extension, Iowa State College, in the "Iowa Engineer."

One might naturally ask the reason for the fixed temperature to which the wet-bulb thermometer drops. This temperature is known as the temperature of adiabatic saturation and is fixed for any dry-bulb temperature and percentage of humidity. To understand this statement, imagine three thermometers placed in a body of air to which moisture is to be added without exchange of heat with any source outside of the air and water. The first thermometer is arranged to show the dew point and reads the lowest. The second, or dry-bulb, thermometer shows the dry-bulb temperature or, as we call it, the temperature of the air. The third thermometer shows a temperature between the dry-bulb temperature and the dew point. To make the case concrete, take, for example, air as 70 deg. and 33 per cent. saturated. Then the conditions are as follows: Dry-bulb temperature, 70 deg.; dew point, 39 deg.; wet-bulb temperature, 54 deg.

If now a fine spray of water having a temperature higher than 39 deg. is introduced, the air absorbs moisture, with the result that the dry-bulb temperature drops at once, the dew-point temperature rises and the wet-bulb temperature remains stationary. The reason is that the total heat of the air is constant. The heat required to evaporate the moisture is rendered latent, and the sensible heat as shown by the dry-bulb thermometer becomes less, but the sum of latent and sensible heat is constant. If moisture continues to be added, the dew-point temperature continues to rise, the dry-bulb temperature continues to fall until all three are stationary at the wet-bulb temperature, when the air is saturated. The total heat of the air is the same as it was before the moisture was added, but it contains more latent and less sensible heat. On the total heat the wet-bulb temperature depends, and therefore it is fixed for any temperature and percentage of humidity, because the total heat of the air in the given condition is fixed.

In the example given the percentage of humidity may be calculated if we know the dry- and wet-bulb temperatures. These are as given, dry-bulb 70 deg., wet-bulb 54 deg. The temperature of adiabatic saturation is 54 deg., and at this temperature the air contains 62.14 grains per pound when saturated. The total heat of the mixture equals the heat of the air plus the heat of the moisture, or

$$0.2375 \times 54 + \frac{1,084.7 \times 62.14}{7,000} = 22.44 \text{ B.t.u.}$$

Since the total heat of the air is constant during the change, the total heat at 70 deg. equals the total heat at 54 deg., or

$$0.2375 \times 70 - (1.084.7) + 0.48 \times 16 \times X = 22.44$$

X = Grains of moisture in air at 70 deg.

0.48 = Specific heat of the vapor.

Solving for X, we have $X = 37.2$ grains per pound of air.

Since saturated air at 70 deg. contains 110.01 grains per pound, the humidity is $\frac{37.2}{110.01} =$ 33 per cent.

A JUVENILE CARVER.

AN AMBITIOUS LITTLE LADY

The little half tone here reproduced from *Granite, Marble and Bronze* shows the interior of the stone carving shop of Mr. C. F. Redding, Hanover, Pa., with his little daughter absorbed in the manipulation of a pneumatic stone carving tool. It is the little lady's ambition to be a good stone cutter, and she is said to accomplish some quite astonishing results. When it was suggested that a picture should be taken she declined unless she could be permitted to put on the overalls "and be a regular boy," and here is the result.

COMPRESSED AIR FOR SINKING A SHAFT

BY F. D. BUFFUM.*

Recently I took a contract for a 650-ft. concrete-lined air shaft to be sunk 3½ miles from Boswell, Somerset County, Penn., for which compressed air power was obtainable free at the power house in Boswell. Its use, as compared to that of a steam boiler plant at the shaft, would effect a saving of $5 to $6 per day in fireman's wages and about the same amount in coal. It was therefore decided to pipe air for this distance.

It was estimated that the machinery to be operated at the shaft would require a maximum of 1,200 cu. ft. of free air per minute. To provide this amount of air with an initial pressure of 100 lb. and a terminal of 80 lb. would have necessitated a 6-in. line, the cost of which would have been prohibitive.

[The drop in pressure under the above conditions of transmission would have been only 8 lb., instead of 20 lb.—Ed. C. A. M.]

A canvass of second-hand pipe dealers showed that there were in stock for sale or lease 10,000 ft. of 4-in. pipe, 3,000 ft. of 3-in. pipe and enough 2½-in. pipe for the remaining distance, capable, if required, of carrying a working pressure of 250 lb. The line was accordingly made up of such a combination. The 10,000 ft. of 4-in. pipe has a volume of about 800 cu. ft., and in order to provide receiver capacity it was laid at the shaft end of the line. The 3-in. pipe was placed next and the 2½-in. pipe covered the rest of the distance to the power house.

A BOOSTER INSTALLED.

In order that this comparatively small line might carry the required amount of air to provide for all contingencies, a "booster" compressor was installed at the power house. This was a 16x11x11-in. Hall single-stage, steam-driven machine. Its inlet was connected to the receiver of the permanent plant and its discharge into the line. With this arrangement the compressor could be cut out or bypassed when not needed, and the line could then take air directly from the main compressors. Twelve hundred cubic feet of air compressed to 6 atmospheres has a volume of about 200 cu. ft. This amount of air passed through the booster and compressed to 250 lb. gage or 264 lb. absolute has a volume of only about 65 cu. ft. This volume would pass through the pipe line described with little drop in pressure.

For use in rock drills, engines, pumps, etc., not more than 100 lb. pressure was desired, and to secure this a Chaplin-Fulton reducing valve was installed at the shaft. It is regulated by weights, which can be quickly placed on or taken off to give any pressure desired, from that in the pipe line down to a very few pounds. It was found that the quantity of air required was not so great but that by raising somewhat the pressure of the permanent compressors at the power house a terminal pressure of 80 to 100 lb. could be secured at the shaft without the use of the booster. The drop in pressure in the line was a variable and depended on the amount of power being used, or the volume of air passing through the pipe.

TAKING THE WATER OUT OF THE AIR.

The most important feature of the plant was, however, the extraction of the water from the air so as to prevent its freezing in severe winter weather and blocking the line. This sometimes occurs in transmitting compressed air in pipes laid on the surface of the ground, as was the case in this installation. The receiver of the permanent plant was located as close as possible to the compressors, so that the air was practically as hot as when it left the machines themselves. Consequently the receiver did not extract the water, and to accomplish this necessary de-watering, the line was laid from the permanent receiver downgrade for about 300 ft. to the bed of a creek, thence under water for about 120 ft. and then up the bank to a receiver located close to a small power house, where men were constantly on duty who could drain it without extra expense.

The air in passing from the compressor to the creek kept the line hot enough to melt snow falling on the pipe, but the creek cooled it, as did also two lengths of pipe through which it passed upward from the creek to the receiver on the bank. The air left this second receiver as cold as it would be at the shaft, and consequently it dropped all the water in the receiver that it ever would drop. There was therefore no gathering of water and freezing in the line.

The cooling of the air to make it drop its water before leaving the receiver was the whole object of this arrangement, which was

---

*Condensed from *Coal Age*.

designed by Mr. Hildebrand, of the Hope Engineering and Supply Co. In warm weather the creek water, being colder than the atmosphere, cooled the air. In cold weather it had also some cooling effect, though the water was not as cold as the atmosphere. It, however, kept the moisture, dropped by the compressed air as it cooled in passing from the compressors to the second receiver, from freezing, because the temperature of the creek water was necessarily above the freezing point, except of course on its surface, where ice formed.

Until they were buried with a steam line beside them, so they could be warmed a little if necessary, the two lengths of pipe between the creek and the receiver gave trouble from freezing when the mercury fell below zero and a strong wind was blowing. The drain on the receiver would also freeze until a small jet of steam was allowed to play on it in the coldest weather, after which it gave no trouble.

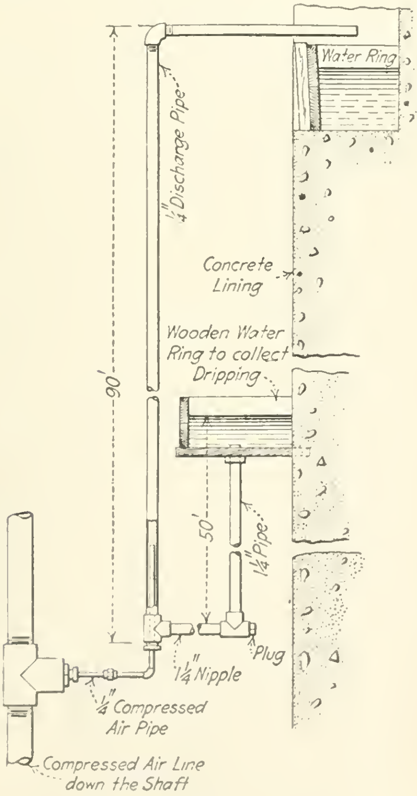
The air delivered to the shaft was perfectly dry, and no case of freezing in the exhaust of any machinery was ever noticed except at times in a 1½-h.p. automatic engine used for driving an electric lighting generator. On account of its variable cutoff and light load this machine expanded the air in its two cylinders more than did the hoisting engines, pumps, drills and engines with throttling governors. The slowing down of this unit was always an indication that the water in the receiver at the power house had not been completely drained off and that some was passing into the line.

After leaving the receiver the air line again passed under the creek, because this was the easiest way to cross it. From here the line proceeded upgrade, except for one small dip, for about 3,000 ft. to a deep hollow. It was expected that if any water got by the receiver it would lodge in this depression if given a chance; so a drip was installed there, experience with the variable cutoff engine having shown that water would occasionally get past the receiver. This was done before cold weather set in, and this precaution was taken in order to avoid any chance of freezing in the line.

The drip consisted of 18 ft. of 8-in. pipe, which formed an enlargement of the line at its lowest point. The air entered this 8-in. section from the 2½-in. pipe and expanded to fill the larger cross-section. This tended to precipitate any water which the air carried. The outlet was through a 2½-in. pipe at the far end. A small drain cock was provided at the lowest point and the whole arrangement was covered to prevent its freezing. This drain section was set so that the far end was slightly higher, allowing the water to drain back.

A few gallons of water could occasionally be drained from this drip, but the bulk of the moisture passed in a steady stream from the receiver drain at the power house, which was always slightly open for that purpose.

The machinery operated by air from the line described consisted of two hoisting engines, a concrete mixer, an electric-light engine and a shop engine (all built for steam operation), two shaft-sinking pumps, a blacksmith forge, an air-lift pump and an air jet for ventilation.



AIR LIFT IN MINE SHAFT.

AN AIR LIFT IN THE SHAFT.

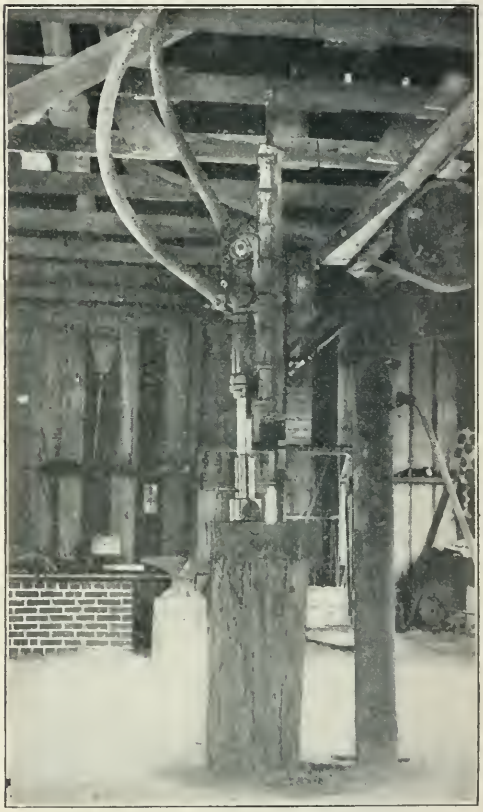
The shaft, see sketch, was provided with a temporary water ring, from which there was considerable leakage, so a second temporary wooden water ring was hung 40 ft. lower. The water in it drains into a 1¼-in. pipe extending about 50 ft. vertically downward to a tee, one branch of which is plugged; the other has a nipple leading to another tee, from which another 1¼-in. pipe leads up so as to discharge water into the upper water ring. Into the bottom vertical branch of the second tee a ¼-in. compressed-air pipe enters and rises about 18 in. into the water-discharge line, which, as just mentioned, leads up from the other branch of the tee. The upper water ring is connected to a pump which discharges the water outside the shaft. This air lift was successful from the start in returning the leakage to the upper ring and pump, which was its object. The plug in the first tee was to facilitate cleaning of the line in case of stoppage.

Below the water rings there are but two pipe lines in the shaft—a 2-in. line for air and a 2½-in. for water. So little water was encountered at the shaft bottom, however, that it was found cheaper to bail it out than to pump it. Consequently the 2½-in. line was turned into a ventilating line.

AN AIR EJECTOR FOR VENTILATING.

As is well known, compressed air does not give much relief when used to ventilate, supposedly because it is too cold and heavy to rise and carry off the gases. A horizontal length of pipe was added to what was formerly the water-discharge line at the top of the shaft so as to get an air inlet far enough away from the shaft mouth to secure pure air, and a 2-in. water ejector was attached. The steam connection of this jet was bushed down for a ¾-in. compressed-air line. When the compressed air is turned on it sucks in the pure outside air through the water inlet, mingles with it and the mixture goes down the shaft through what was the water line, making an effective ventilator, which never gives trouble. The suction of the entering air is about the same as that of an ordinary house-cleaning vacuum system.

The main use of this ventilator is in clearing the shaft of dynamite fumes after shooting. For this purpose, if necessary, steam from a small boiler instead of air can be turned into the air line; but so far this expedient has not been necessary. Steam is of course more effective in clearing away the fumes than air, but in this case its use would necessitate the firing of a boiler for this purpose alone.



ELECTRIC-AIR DRILL AS A BLACKSMITH'S HAMMER

The half tone on this page shows a portion of the interior of the blacksmith shop at Gaunt's Quarry of the Alabama Marble Company, and it mostly tells its own story. The object of interest is the power hammer in the foreground. This is a regular and complete electric air drill of familiar type which has been installed for regular service as a power hammer for the heavier work of the blacksmith. A heavy anvil block is mounted upon the end of a log sunk in the ground the drill chuck carrying a suitable hammer face. At the side of the anvil log a long 6 in. pipe also is firmly bedded with a cast iron elbow bolted to a flange at the top and to the vertical face of the elbow the drill guide is attached. A stay attached at the back just below the elbow helps to steady the pipe or column. The pulsator is located upon timbers overhead. The drill can be run up or down by the feed screw according to the height of the work on the anvil. It goes without saying that the performance of the hammer is entirely satisfactory.

DRILL STEEL SHARPENING

The following article by Mr. Lucien Eaton, Superintendent of Mines, Cleveland Cliffs Iron Co., Ishpeming, Mich., here reproduced from a recent issue of Mining Press, San Francisco, follows an interesting article in our issue for June by Mr. P. G. Beckett, Mining Engineer, and Mr. I. H. Barkdoll, Mine Superintendent, Old Dominion Mine, Globe, Arizona. Both articles represent successful and established practice, but the particulars are well worth noting, especially as to the differences of gage for the successive lengths of steel. Referring to the previous article, Mr. Eaton says:

I have read with interest Mr. P. G. Beckett's article on "Drill Steel Sharpening at Old Dominion Mine." With a few exceptions the practice at the Old Dominion follows closely the standard Lake Superior Practice of two or three years ago. The greatest variations from present practice are in the large difference in gage for successive lengths of steel, and the welding of "Rocky Mountain" steel on round shanks. It is evident that the ground at the Old Dominion mine is not hard on the gage, otherwise it would be impossible to standardize on two-foot changes; and it is probable that more careful forming of the bits would make it possible to reduce the changes in gage to ⅛ in. and possibly 1-16 in. instead of ¼ in.

The advantage to be gained by such a change is obvious. Assuming that the gage of the longest length of Leyner steel remains at 1¾ in., changes of ⅛ would make the starter 2⅛ diameter instead of 2½, with a cutting area only 70 per cent. that of the starter at present used. If 1-16 changes are used the starter would be 1 15-16 diameter, and the cutting area would be little over 50 per cent. of that of the 2½ in. starter. As a matter of fact the reduction in cutting area, with its consequent increase in drilling speed, would be greater than I have indicated, for the gage of the long drill could be reduced to 1⅝ and still give plenty of room for 1½ in. powder.

I do not wish Mr. Beckett to consider my remarks as adverse criticism of the practice at the Old Dominion mine, as I am not thoroughly enough acquainted with conditions there to pass judgment. I feel confident however, that as much can be done in reducing gage-intervals there as has been done already in the iron and copper districts of Lake Superior. In the Copper Country, Mr. C. D. Lawton, of the Quincy Mining Co., and Messrs. M. M. Morrison and Ocha Potter, of the Calumet & Hecla Mining Co., have perfected their drill-design and drill-sharpening practice to such a degree that they standardize on 1-16 changes in gage for 2-ft. changes in length.

At the Cliffs Shaft mine at Ishpeming, the largest hard-ore mine operating on the Marquette range, I have made it standard practice to use a 1-16 change in gage for foot changes in length, the gage of an 8-ft. drill being 1⅝ in. Six years ago standard practice was to use ⅛ changes in gage for 6-in. changes in length of steel. The steel now used is 1¼ hexagon hollow FJAB No. 10, without lugs. There are 55 Leyner machines in use, of which 35 are using steel with 1-16-gage changes. The other 20 have not yet been changed over from ⅛ intervals..

The rapid strides made in improving drill-bits and drill-sharpening methods have followed the introduction of the Carr bit and are the result of the study of its peculiarities. The Carr bit now used is essentially different from the bit originally designed by Mr. Carr. The original Carr bit had a single cutting-edge, finished at an angle of 120°, with an enlarged hole in the middle. The wings of the bit were formed on a true cone with a taper-angle of 5°, and the flat sides tapered toward the cutting-edge at 4°. In many instances all of these angles have been changed, and the bits are not made on a true cone. It is essential that the two ends of the cutting-edge and the four corners, where the faces of the bit meet the flattened sides, should cut the same circle. This necessarily means that the circle on which the wings are formed shall be larger in diameter than the gage of the bit, the diameter being determined by three factors, namely, the angle of the cutting-edge, the taper of the wings, and the thickness of the bit at the corners. A change in any one of these factors changes the diameter of the wing-circle. In some kinds of ground Carr bits are not a success, but the principles of their design are equally applicable to cross-bits, and there is no reason to believe that with them results will not be as gratifying.

DRILL SHARPENING PRACTICE.

Following is a brief description of the drill-sharpening methods in use at the Cliffs Shaft mine: Three kinds of steel are used, 1¼ hexagon hollow steel for Leyner drills; 1¼ round solid steel for 3¼ piston-drills, and 1-inch round solid steel for raising-drills. Two styles of bit are used on the Leyner steel: cross-bits and Carr bits. The cross-bits are sharpened in a No. 3 Leyner sharpener, and are gaged in the dies. The gage-changes are ⅛ inch, and the changes in length one foot. The Carr bits are sharpened in a No. 5 Leyner sharpener, but are not sharpened in the dies. The steel is held by the dies, and the bit is 'upset' in the open air, one dolly and one pair of dies serving for all sizes of bit. The steel is flattened between special dies, and is 'swaged' for the wings during the sharpening process in a pair of formers with 15° taper. It is upset to ⅛-in. greater diameter than the gage, and is then brought back to gage by being squeezed in a pair of formers with 6° taper. This method of forging facilitates drawing out the corners. All cross-bits are sharpened in one heat, but Carr bits often require two. On the cross-bits the angle of the cutting-edge is 90° and the taper 15°. On the Carr bits the angle of the cutting-edge is 120° and the taper 6°. All Leyner steel is made without lugs, the shanks being bored out to ⅜ in., countersunk, chamfered, and squared, and then tempered in oil. Breakage is very low.

The solid steel for the raising-drills is sharpened in the No. 3 Leyner sharpener in the same manner as the cross-bits for the Leyner drills, the gage changes being ⅛ in. per foot. The solid steel for the piston-drills is sharpened in a Word sharpener. Cross-bits are used with the angle of the cutting edge 90° and the taper 12°. The changes in gage are the same as for the other cross-bits. The practice of welding 'Rocky-mountain' steel onto the round steel was discontinued about four years ago.

All steel is given a forging-heat from 2 to 2½ in. long in a No. 9 Bradley coke forge, and is allowed to cool thoroughly before being heated for tempering. The tempering heat is made as short as possible, and the bits are quenched by plunging into a tank. The tempering heat is given in a No. 11 Bradley coke forge.

Steel for the piston and Leyner machines is marked on the shank with the number of the contract to which it belongs, and after tempering is sorted and placed in a large rack, in which each contract has a pigeon-hole. The steel for each contract is made into a bundle and held together by an iron ring and wooden wedges. The contract number is then written on one of the wedges with a blue crayon.

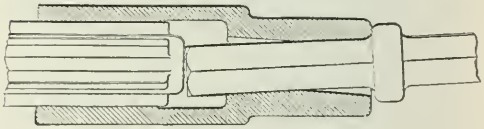


Fig. 1.

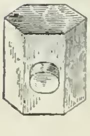


Fig. 2.

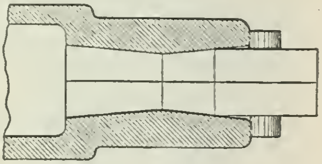


Fig. 3.

CONVENIENT INSPECTION GAGE FOR HAND DRILLS

BY C. C. PHELPS.

There are as many different ways of running a jackhamer as there are of killing the cat of proverbial distinction. One man is partial to the use of his right hand as the guiding force, another uses his left. Another uses both his hands, bearing down with all his weight. It is not unusual to witness a drillman in a restful pose, with one leg slung over the handle as in the half tone herewith.

Motion study does not play much part in the efficient operation of this type of drill. About the same footage can be drilled, irrespective of the way the machine is handled. This is of course largely due to the fact that the rapidity of the hammer blows rather than their force accomplishes the speedy penetration; and the automatic rotation obviates rifling.

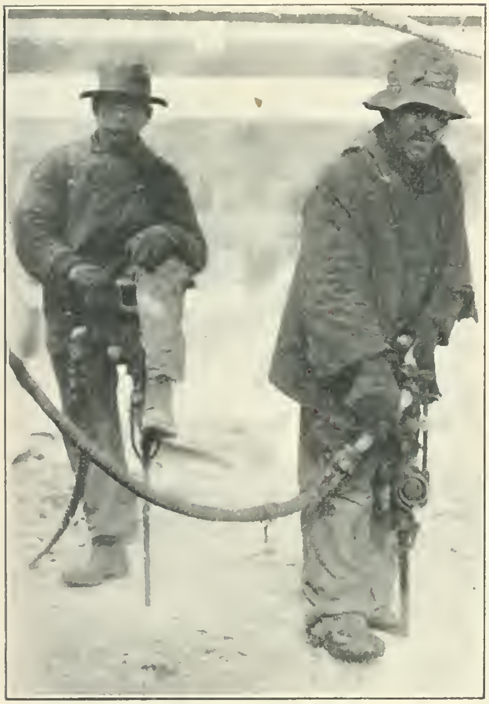


FIG. 4.

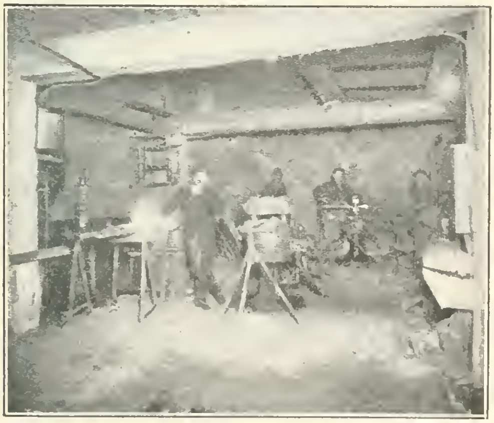
There is, however, one bad feature about careless handling of hand drills which is not generally appreciated—its tendency to increase the repair expense. Careless handling of the machine will tend to keep the steel and drill out of line, and in time this will wear the rotation sleeve in the front head of the drill, as illustrated in Fig. 1. The piston is designed so that the center of its face will strike squarely on the head of the steel shank. It is apparent that excessive wear of the rotation sleeve will permit the end of the shank to come in contact with the edges of the striking face of the piston, eventually chipping off pieces of the latter. These fragments may wedge around the steel or lead to further fracture of the piston. It is therefore highly desirable to inspect the rotation sleeve periodically and replace it before it wears to such an extent as to endanger the proper working of the piston.

For the purpose of determining when a worn sleeve should be replaced, a gage such as that shown in Fig. 2 is used by the test department of the Ingersoll-Rand Co., in connection with experimental machines. This gage, consisting of a piece of 15-16-in. hexagon steel with a pin through it, of about the proportions shown, is used for testing sleeves for ⅞-in. hexagon shanks. When the sleeve has worn sufficiently to permit the gage to enter and the pin to rest on the front head, as shown in Fig. 3, it is an indication that the permissible limit of abrasion has been reached, and that a new rotation sleeve should be substituted.—*Eng. and Min. Journal.*

BLACKSMITH SHOP IN ALASKA MINE

Until the invention of the oil-burning forge in recent years, it was impractical to place the mine blacksmith shop underground because of inevitable vitiation of mine air which is bad enough at best.

An interesting use of an oil-burning forge is shown in the accompanying illustration in a prominent Alaskan gold mine. This shop is situated on the 2,100-ft. level and about 935 ft. from the shaft. The forge, shown at the left end of the picture, is not divided with smoke or gas flue, and yet the men work without the slightest inconvenience or impairment of health. No special means are used to ventilate this chamber, the conditions being those prevailing in any well-managed mine. This forge supplies the two Leyner sharpeners and accomplishes the duty formerly assigned to two forges operated on the surface. The great advantages accruing from this installation are the avoidance of hoisting and lowering the drill steel, which, in turn, results in the elimination of two nippers on the surface,



the readiness with which every drill-runner is always kept supplied with the proper bits, and—a most important item—an increased ore-hoisting capacity. A similar installation is planned for the 2,300-ft. level, with corresponding economies. The forge in question is the Case low-pressure oil forge made by the Denver Fire Clay Co. The consumption of the fuel varies somewhat, depending on its grade, from 1 to 1½ gal. per hr. It has been found that cheap, ordinary fuel oil, California tops and first or second distillates make a suitable fuel.

The capacity of this forge, when used steadily in large mine shops, is about nine 1¼-in. steels per minute—sufficient to keep the tender busy.—*Eng. and Min. Journal.*

TAMPING TRENCH FILLING

The most important point in the back-filling of trenches excavated in paved streets is the proper tamping of the material. Hand tamping is universally recognized as expensive, and, at the same time, quite often inefficient, and it is well, where practicable, to perform this work by mechanical means. Where compressed air is available, the Crown floor rammers (type 22-SR) manufactured by the Ingersoll-Rand Co. may be used to good advantage. These machines, which consume 28 cu. ft. of free air per minute at a gage pressure of 100 lb. per square inch, are easily operated by one man, who does not need to be a skilled laborer, and they do not require any great amount of care to keep them in order, aside from cleaning and oiling.

Comparative tests of hand tamping and machine tamping have shown that the cost of the latter is about one-third the former, and, at the same time, the backfill is much better tamped.

We have backfilled a 50-ft. section of trench, 24 in. deep and 20 in. wide, containing 6.3 cu. yd., in one hour, with three men shoveling and six men tamping. This backfilling cost $1.80, or 28 ct. per cubic yard, and this ratio of tampers to shovelers insures good tamping. The tamping cost in this instance was 19 ct. per cubic yard.

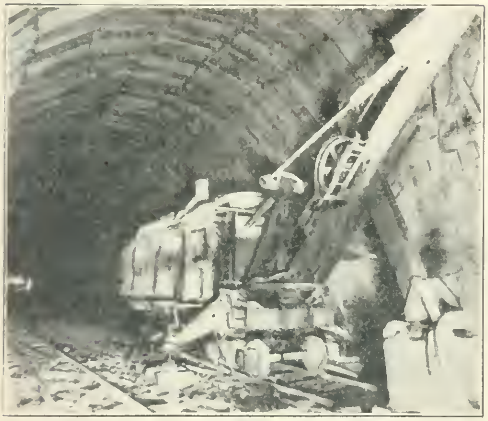
Another 50-ft. section 27-in. deep and 20-in. wide, containing 7.1 cu. yd., was backfilled and machine tamped in one hour, four men shoveling and one man running the rammer. I have never seen earth filling better compacted than it is by these tampers. The cost of this backfilling was 18 ct. per cubic yard, and of the tamping alone, 6.9 ct. per cubic yard.

Other tests have verified these figures, and we have found that, as a rule, the cost of tamping with these pneumatic rammers, on this class of work, is about 7 ct. per cubic yard.

The accompanying illustration shows one of these tampers in operation on Burnside Ave., East of University Ave., Borough of the Bronx, New York City.—*C. M. Hartley in Engineering and Contracting.*

ENGLISH EXPERIENCE WITH PUTTING THE CLOCK AHEAD

The market seems pleased with the Summer Time Act, as it is officially called, or "Daylight Saving," as the public persist in terming it. On Monday, there were no late arrivals at Offices, and the banks had nothing fresh to report. Scarcely anybody seems to feel the difference until evening approaches, which is longer and more pleasant. There is earlier shopping, and trade seems to have benefited rather than the reverse. Trains run according to the "Willett time-table," and, in a word, the only difficulty seems to have been with the cows, which refuse to be milked an hour earlier than usual. As a milkman said when remonstrated with on the late arrival of his commodity: "It ain't no use your putting on the clock if the cows won't give their milk before time."



AIR OPERATED SHOVELS IN TUNNEL WORK

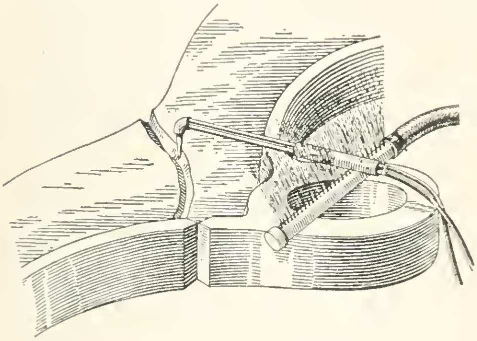
The driving of tunnels for railroad or other service is now such a familiar operation that there is little occasion to mention or describe each undertaking specifically unless there are some novel or unusual conditions involved. The Woodhill and the East Brady tunnels on the Allegheny Division of the Pennsylvania Railroad, begun in 1913 and completed last summer seem to have been in that category, but the photo here reproduced taken while the work was in progress should be of interest to our readers.

The conditions encountered in both tunnels were quite similar. The material for the most part was soapstone and sandstone and crumbled rapidly when exposed to the air so that it was necessary to carry the timber close to the heading. The tunnels were driven by the usual top-heading method by hand. The mucking was done by air operated shovels, one at each end of each tunnel. There were two Bucyrus 40-R's and two Marion Model 41's all with 1½ yard buckets. The half tone shows a 40-R Bucyrus in the mouth of the East Brady tunnel.

The air for the shovels was supplied by two Ingersoll-Rand and one Chicago Pneumatic Compressor. The shovels would work with the pressure as low as 40 lb., but 100 lb. generally maintained was more satisfactory and economical. The material was loaded into two 6-car trains for each shovel. Western 4 yard cars and 18 ton Vulcan locomotives were used. Conditions were not favorable for rapid work, one shovel averaging about 200 yards per day, working 6 hours. The material was dumped along the river bank.

The concrete for lining the tunnel was also conveyed and deposited by compressed air.

The work was contracted by the Allegheny Construction Company of New York, Arthur McMullen, president.



A CURTAIN OF AIR JETS

The failure of a heavy welding job can often be traced to the discomfort of the operator. To stand up to a large preheated casting is often quite a task.

Where air pressure is available, the device shown in the illustration will be found useful. A row of small holes is drilled in a pipe of convenient size to attach to the air hose. The other end of the pipe is closed.

This contrivance is placed across under the torch and held by a clamp or a weight in such a position that a curtain of swiftly moving air passes between the hot casting and the operator. The device affords protection from the heat and does not interfere with the manipulation of the torch or obstruct the view of the operator.—*H. Howard in American Machinist.*

COMPRESSED AIR FOR MIXING AND FOR CONVEYING CONCRETE

In an able article on "Equipment and Operation of Concrete Plants," by A. W. Ransome, in *Contracting*, June, 1916, occurs the following:

Compressed air has been more or less used of late and some extravagant claims have been made as to results. The fact remains, however, that the so-called compressed air mixers do not mix successfully. Compressed air will, however, successfully transport premixed concrete, and in tunnel work will place it economically. Francis Donaldson of the Degnon

Contracting Company used one of these pneumatic machines on the 59th Street section of the new subway. It was a success in placing the mixed concrete, but was rejected as a mixer by the engineers of the Public Service Commission.

THE WATER HIGHWAY AND THE GLIDING BOAT

The following is a brief abstract of a lecture given Jan. 3 by Gonzalo Mejia, of Colombia, before sections of the Second Pan American Scientific Congress.

There is one problem that is common to us all. We have boundless natural resources; we have untold wealth of every description; nature has lavished her rarest gifts upon us. But in order to bring them forth and to derive from them those benefits which are hers by right, South America must have means of communication.

Now, we all know that no network of railways covers the Southern Hemisphere, that many decades must elapse before they can be built; but if we are without an artificial highway, if the rails patiently laid down by the toil of men are lacking, we have a superabundance of natural highways—of mighty rivers which, with their myriad tributaries, stretch in all directions over the face of our native lands. Hitherto they have been of little use, either for intercommunication or for transportation, because our South American rivers abound in shallows and in sand bars and are mostly navigable only for slow rear-wheel boats of insignificant draft.

As air-propelled gliding boats have to overcome only air resistance and the friction of the surface of the waters, the increase in their speed calls for no such enormous increase in motor force as is the case in the regular boats, which have to cleave their way through the waters as they proceed, or even as is the case with the regular hydroplane, the resistance of the water to the submerged screw and shaft of which offset the advantages gained by their gliding qualities. It is a demonstrated fact that at all speeds over 40 miles an hour, the air propeller is more efficient than the propeller in the water for the gliding boats. The record of the regular hydroplane, with submerged screw, is 59 miles an hour, but needed 750 horsepower to attain such a speed. In France, Paul Tissandier made, in 1913, 60 miles an hour in a hydroplane with air propeller and 160 horsepower.

The advance of civilization with all the material prosperity that modern development brings in its train depends upon ease and rapidity of communication. All of that fabulously rich but actually railroadless continent that we South Americans love and cherish as our homeland can be transformed almost over night into one of the portions of the earth best provided with means of communication.

The possibility of building air-propelled boats capable of gliding over the surface of the waters at high speed, safely and surely, is not a theory. It is a fact. There is the *Yolanda* which I have taken up and down the Hudson river for months. I have had on board his excellency the minister of Colombia, Don Julio Betancourt, who can bear me witness, with a number of other gentlemen, that we came from Nyack to New York, a distance of 22 miles, in 35 minutes.

Latin Americans, there is a man who believes that your rivers can be changed into splendid roads, roads that will never show signs of wear no matter how heavy the traffic. This gives you the one thing you lack, means of communication.

NEW SUBAQUEOUS TUNNEL RECORD

What is believed to be a new speed record in driving subaqueous tunnels with the aid of compressed air has been made in the Dorchester rapid transit tunnels under Fort Point Channel, Boston. The best month's run in one tube was 375 ft. of completed tunnel. The average run for the best three months was 325 ft. per month, a large portion of this being in hard-pan. All spoil had to be brought through the shield and out of the air-locks. When the air pressure was first used on the tunnels, early in June, 1915, no provision was made for cooling the air, but aftercoolers were installed a little later. These were 3 ft. diameter and 12 ft. long with about a hundred and twenty 1½ in. brass tubes through which harbor water was circulated.

American ports are better suited by nature to handle the largest liners than any of the old-world ports. At New York, San Francisco, Seattle and Tacoma boats as large as the Imperator or the Aquitania can be docked at any stage of the tide.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE

Compressed Air Magazine Company
Easton, Pa.

New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. JULY, 1916. No. 7

CONTENTS

Compressed Air at Rockland Lake...... 8035
Blasting for Clams...................... 8038
Enlarging a Tunnel in Alaska........... 8039
Air Lenses for Divers' Spectacles...... 8039
Pirahy Tunnel in Brazil................ 8040
"Notowl" for Drying Face and Hands.. 8045
Atmospheric Humidity 8046
Ambitious Little Lady.................. 8047
Compressed Air for Sinking a Shaft.... 8048
Electric-Air Drill as Blacksmith Hammer 8050
Drill Steel Sharpening.................. 8051
Inspection Gage for Hand Drills........ 8052
Blacksmith Shop in Alaska Mine........ 8053
Tamping Trench Filling................. 8054
Air Operated Shovels in Tunnels........ 8055
Compressed Air for Concrete........... 8055
Water Highway and Gliding Boat...... 8056
New Subaqueous Tunnel Record........ 8056
Multiple Effects of Improved Facilities.. 8057
Water Power and National Defense.... 8058
Value of a Suggestion.................. 8058
Cost of a Crosscut Adit................ 8059
Compressed Air Solves a Water Problem 8060
Notes 8061
Patents 8062

MULTIPLE EFFECTS OF IMPROVED FACILITIES

We are constantly reminded in all lines of experience of the general principle enunciated by Herbert Spencer, though probably not originating with him, that every active cause is followed by more than one effect. We have an illustration of this in the article upon drill sharpening at Old Dominion mine, Arizona, in the June number of Compressed Air Magazine and, following that, the account in our present issue of drill sharpening practice at Cleveland Cliffs mines, Michigan.

In both cases the pneumatic mechanical drill sharpener is employed, the first result of which is the reduction in the cost of drill maintenance. The ease and quickness with which drills can be resharpened by this means leads to their more frequent renewal, so that when the bits are actually in use they can be working at full efficiency and no time is lost in trying to get all that it is possible to get out of a bit after it is partially worn, or too much reduced in gage. The machine-forged bits are more correct in shape and more accurate to gage, so that the individual difference of gage in the successively following bits is reduced, which means a considerable reduction in the drill hole area for all the steels except the last, consequently a considerable reduction in the amount of chips to be removed and an actual increase in the speed of linear advance, and in the total length of hole per unit of time.

The cheapening and quickening of the drilling does not end with itself but makes it necessary for the other associated operations to be quick and also to keep out of the way of the drilling, so that there is no telling where the influence of the drill sharpener ends. The possible advantages thus made apparent become actual only when they are recognized and appropriated, and, that these advantages may not be missed by any, it is good to talk over, in the technical press or elsewhere, what we each are doing, comparing results and stimulating the worst to emulate the best.

And thus we come upon the everlasting industrial paradox that the doing of any line of work quicker and cheaper and better is the surest way of providing more work to do, one thing leading to another, or to two or three others, without end. Public works of every character are successively made possible by the increase of the facilities and the cheapening of the methods of execution, so that new enterprises can be planned and profitably carried to completion which only a generation ago could not be thought of, and this mechanical drill sharpener of which we here speak, this glorified blacksmith's helper, stimulates the driving of longer tunnels, the sinking of deeper mines, the winning of additional profits all around, the greater gains coming not from the building of the machines but from the constant use of them.

WATER POWER AND NATIONAL DEFENSE

BY W. R. WHITNEY.

The United States has no adequate source of fixed nitrogen. Nitric acid is an absolute necessity in the manufacture of any form of explosive stuffs. Ammonia or nitrate compounds are in increasing demand as fertilizers. The present dependence upon Chile is a menace in case of war and involves the payment of export duties and profits amounting to nearly $5,000,000 annually in time of peace. Home production is wholly a question of initiative and proper utilization of water power. Failure to establish the industry in the past has been due to economic conditions, such as the relative proximity of Chile and the impossibility of competing with the cheap water powers of Scandinavia as well as lack of a near-by agricultural demand. The growing need for fertilizers, the desirability of establishing a dyestuff industry, and, especially, the feeling of uncertainty in international relations make a reconsideration desirable.

National safety demands the development of a nitrogen fixation industry, whether it be self-supporting or not. But, the industry once established, the products would be of the greatest value in times of peace and would be stimulated thereby. Thorough industrial organization is the best preparedness for either peace or war. Each of the processes available has advantages. The problem is many-sided and far-reaching, and hence it is very desirable that the various government departments concerned, those of the Army, Navy, Agriculture, and Interior, with their skilled staffs and expert knowledge, should co-operate in determining the course to be taken. Immediate action is very important, since at least two years will be consumed in getting any process available into operation after a decision is reached.—*American Institute of Electrical Engineers.*

VALUE OF A SUGGESTION

Dr. Douglas and I were visiting certain works at Swansea to inspect and report upon a patented process or machine, the inventor of which had the right to show it. We were hurried through the old-fashioned smelter, the proprietors evidently not wishing us to see anything except the particular apparatus which was the reason of our visit; but passing a small converter with which some men were tinkering, Dr. Douglas asked them what they were trying to do. With a little reluctance, they told him that they were trying to bessemerize a 37% copper matte, but that their experiments were unsuccessful because their charge continually froze. He asked them what was the pressure of air blast they employed. They said, so many ounces. He replied, "No wonder you froze up! Give the furnace so many pounds." The superintendent exclaimed, "Why, if only a few ounces of air blown in freezes the charge, the same result would be hastened if we increased the pressure!" Nevertheless, they apparently tried it after we left, and when we arrived at our hotel in London, Dr. Douglas received a telegram from the works manager, telling him of their success and thanking him for his hint. Afterwards, he received a formal vote of thanks from the directors.—*Dr. Albert R. Ledoux, Bulletin A. I. M. E.*

AEROPLANE CARRIES SUPPLIES TO A MINE

The aeroplane this spring struck a job of real work, carrying supplies regularly to an isolated mine in British Columbia. At the Dolly Varden mine in the Alice Arm district, a branch of Observatory inlet, a shutdown was threatened on account of the giving out of supplies, due to the unusually prolonged winter weather. A contract was made with the California Aeroplane Co., at a cost of $600 per month and expenses, for an average of two round trips per day between the company's wharf on Alice Arm and the mine, 14 miles distant. Supplies to the amount of 600 lb. were to be carried on each trip.

COST OF A CROSSCUT ADIT

BY W. J. ELMENDORF.*

The main working of the Portland Canal Tunnels, Ltd., consists of an adit 3,671 ft. in length, it crosscutting what is known as the fissure zone of Glacier Creek. The portal of the adit is about 3½ miles north from Stewart, B. C., and 350 ft. above mean high tide at that point.

The heading, 7½x8 ft. in the clear, was driven a distance of 2,916 ft. at an average rate of 8 ft. per day. The best weekly record was 67 ft. and the best monthly 271 ft. Two 8-hr. shifts per day were employed, consisting of four machinemen and three shovelers. After the 1,000-ft. mark was passed, four shovelers were employed. Compressed air at 100-lb. pressure was delivered into the tunnel through a 4-in. pipe. Two 3¼-in. Ingersoll-Rand E44 drills, mounted on a 7-ft. single screw bar, were used. Miners and shovelers started work together. The bar was set up above the rock pile, and from 10 to 12 holes were drilled from this position. By this time the rock was out, the bar was lowered, and three lifters were drilled. The first 1,600 ft. of the tunnel is in greenstone, while the remainder is in argillites, quartz and porphyry

With but two exceptions during the entire work, a round was drilled in every shift. Five-foot rounds were drilled, but seldom "bottomed." Three 20-cu. ft. cars were used, and tramming was done by the shovelers. The track of 20-lb. rails, 18-in. gage and ½% grade, was laid on the left-hand side of the tunnel. One switch, about half way in, was used; the empty incoming car was taken off the track near the face to allow the loaded one to pass. At a point 730 ft. from the portal an 80-ft. adit was run, opening into a cañon. This not only made an excellent dumping place, but shortened the tramming distance by 750 ft. The shovelers laid and leveled the track. The floor from within 3 ft. of the face to 40 ft. back was covered with steel plates before blasting. A drain 12 in. deep was made on the right side of the tunnel, the lifter being drilled low for this purpose.

Ventilation was provided by two Schütte & Körting blowers. The ventilating line consisted of 10-in. diameter 24-gage galvanized pipe. The pipe was made in 10-ft. lengths with riveted joints, painted with tar and wrapped with muslin. The compressor was run two hours after blasting to clear the tunnel.

TIME AND COST OF OPERATIONS

Average Time of Operations

	Hr.	Min.
Picking down and setting up....	1	00
Drilling from upper set-up......	4	30
Shoveling back and lowering bar	0	30
Drilling from lower set-up......	1	15
Tearing down	0	10
Blowing out holes...............	0	5
Loading	0	15
Total	7	45

Detailed Summary of Costs

Labor:	Cost per Foot
Machine men	$3.953
Shovelers	3.673
Timbering	.258
Drainage	.042
Ventilation	.077
Ties and wedges................	.135
Compressed-air line	.072
Compressor men	1.166
Blacksmith and helper..........	1.216
Superintendent	.876
Total	$11.468
Supplies:	
Powder	$2.562
Fuse	.134
Caps	.032
Candles	.145
Blacksmith coal	.125
Machine drills and parts.......	.503
Drill steel	.118
Timbers	.052
Repairs on compressor..........	.027
Oils	.031
Miscellaneous	.073
Total	$3.802

Equipment:	Total Cost
Muck sheets	$110.00
Steel rails	1,290.00
Ventilators	225.00
Ventilating pipe	960.00
Compressor air line...........	1,070.00
Cars	400.00
Total	$4,055.00
Length of tunnel...............	2,916 ft.
Total cost	$48,584.01
Cost per foot..................	$16.661

All supplies were bought at Vancouver, B. C., and sent north by steamship. The prices of some of the more important supplies at the tunnel were as follows: Dynamite—40%, $0.134 per lb.; 60%, $0.159 per lb. (powder was used in about the proportion of 30% of the former to 70% of the latter); steel rails (20-lb.), $72.24 per long ton; blacksmith coal, $27 per ton.

The scale of wages was as follows: Machinemen and shovelers, $4 per day; blacksmiths and compressor men, $5. Beyond the point to which these figures apply, the size of the tunnel was cut down and the costs decreased about $1 per foot.

---

*Can. Min. Inst.

COMPRESSED AIR SOLVES A CITY'S WATER PROBLEM

After years of perplexity, of partial successes and more than partial failures, the problem of securing a satisfactory and permanent supply of water for the city of Joliet, Illinois, has been happily solved by the adoption of the air lift. Water is present in more than sufficient quantity in the neighborhood of Joliet. The Chicago drainage canal runs through the heart of the city, and it would have been possible to purify this for domestic use, but the citizens quite naturally declined to use it and artesian wells were adopted. There is a water bearing stratum 600 to 900 ft. below the surface, which, however would not yield a sufficient supply, but the Potsdam stratum at a depth of 1,600 ft., and 110 to 150 ft. thick can be relied upon both for quantity and quality. It normally rises to 100 ft. from the surface.

There are now 10 wells running to the Potsdam stratum, located at widely separated points, generally encircling the principal section of the city. These wells are quite uniform in general details. For the first 300 ft. of depth there is a 16 in. casing, and below this is solid rock with no casing provided except where caving might occur.

The equipment which has been adopted as standard for the wells consists of a Harris air pump placed at the bottom end of a 6½-in. discharge pipe. The running submergence desired is 55 per cent., but at some wells it is 50 per cent. The average static head is 100 ft., and the recession 100 ft., making a working head on the air-lift pump of 200 ft. and the depth of the air-lift pump 450 ft. An auxiliary air line is placed at such a depth that no greater air pressure is neded for starting than for running. At most of the isolated plants the water is discharged through an umbrella head or reverse bend into a concrete weir box from which it is pumped by means of triplex pumps into the city mains.

At the main pumping station are 4 wells which discharge into reservoirs. The wells being located 300 to 350 ft. from the reservoirs, it is necessary to pipe the water horizontally from the wells and elevate it about 10 ft. from the top of the wells, so Harris boosters are employed here.

PUMPING INSTALLATION.

The mechanical equipment employed comprises one main plant and six isolated plants, electric power for driving the latter being supplied at a low rate by the Public Service Corporation, while at the main plant the air compressors are similarly driven and the power pumps are driven by steam.

At the main plant are two Ingersoll-Rand, Imperial XB, compressors, each 22 and 13 dia. of air cylinders by 16 in. stroke, compressing in two stages to 100 lb. gage pressure. The drive is by Westinghouse induction motors of 200 h.p. each, with short-belt drive. The air intake is through screened pipes from outside, and the delivery to individual air receivers also outside the walls. From the receivers the air is taken through a manifold to the wells.

There are here two reservoirs which receive the water direct from the wells and hold it in storage for night use, when the isolated plants are shut down, and for emergency use as needed. There are two steam driven pumps for delivering water from the reservoirs into the mains. Jet condensers are used with these pumps.

The Washington Street or main plant takes care of all peaks on the system and is in operation day and night. All pressure pumps discharge directly into the mains, but the pressure carried at different stations varies with the elevation. The minimum pressure at the highest elevations of the city is 25 lb. In case of fire, the pressure can be raised to 150 lb., the pipes being sufficiently strong.

Each isolated plant pumps from one well, the machinery consisting of a motor driven air compressor and a motor driven triplex plunger pump.

At the Ottawa St. plant, water is delivered at the rate of 1,000,000 gal. in 24 hr Air is compressed by a Laidlaw-Dunn-Gordon 2-stage compressor to 90 lb. pressure and the water is delivered to the mains by a Deane of Holyoke triplex pump. One 200 h.p. motor drives both machines through belt connections.

The Canal St. well has a capacity of 900,000 gal. in 24 hr. and the machinery here consists of a Laidlaw-Dunn-Gordon compressor and Deane of Holyoke pump driven by individual motors. At this plant, the water from the well is slightly contaminated with oil and gas, presumably from a gas plant nearby. Although every possible precaution was taken to prevent water from upper strata from getting into the well, the trouble still existing, and to overcome the trouble the city engineer, C. D. O'Callahan, devised a scheme for aerating the water which has eliminated all objections.

AERATING THE WATER.

Water from the well is discharged over steps and descends into a concrete reservoir 75 ft. long to 20 ft. wide and 7 ft. deep. This is divided into compartments of about 7 ft. each with a center wall passing longitudinally through the reservoir. The partitions forming the several compartments in the reservoir act as baffles, the water passing over one and under the next one and so on up one side and back on the other, the partition in the center forming virtually 2 reservoirs.

A system of pipes is laid leading into each compartment of the reservoir, which were perforated and rested upon the bottom of the reservoir. Air is delivered through these pipes to each compartment at low pressure, allowing the air to bubble up to the surface, causing little agitation at the surface of the water. A considerable amount of oil and grease collected on the sides of the first compartment in the reservoir which receives the water after it passes down the steps. Small amounts were also collected in the next and succeeding compartments, but by the time the water reaches the last compartment no oil appears on the surface and the odor of gas is entirely eliminated.

At the time of the last test, the Desplaines St. well delivered water at the rate of 500,000 gal. in 24 hr. The equipment here is an Ingersoll-Rand compressor and a Goulds triplex pump run by belts from individual motors.

An Ingersoll-Rand compressor and a Goulds triplex pump with individual motor drive are installed in the Spruce Slip plant. When last measured, this well was yielding water at the rate of 540,000 gal. in 24 hr.

At the Van Buren St. well a Laidlaw-Dunn-Gordon air compressor and a Deane triplex pump are driven by individual motors, the flow of water at the last measurement was at the rate of 540,000 gal. in 24 hr.

The most recent plant of the system is at the Ruby St. well. Here an Ingersoll-Rand compressor and a Goulds triplex pump driven by individual motors are the principal machines. The switchboard equipment at this plant is the standard which has been chosen for future installations and consists of 3 panels upon which are mounted 2 circuit breakers and a polyphase watt-hour meter, 2 controllers and 2 rheostats complete the equipment, all of which was made by the Westinghouse company. This well yields at the rate of 1,500,000 gal. in 24 hr., the air compressor being driven by a 150-hp. motor and the running head against which the water is raised is 250 ft.

For the information here presented we are indebted to a more elaborate illustrated article in Practical Engineer, Chicago, June 1.

NOTES

Some English railway companies have been disconcerted lately by receiving claims for damage to flour through its getting wet, where there were no signs of the tarpaulins being defective, if conveyed in open wagons, or of rain beating through the doors if vans were used. The explanation has now been found in the fact that through the millers working at high pressure, the flour is loaded whilst warm, and this has brought about condensation from external cold.

Sir Robert Hadfield, the noted English maker of projectiles, is authority for the statement that the useful life of a modern high-velocity gun is about three seconds. Which is to say that the time taken by the shell in traveling through the gun, from powder chamber to muzzle, multiplied by the total number of rounds that can be fired before the rifling is so worn as to impair the accuracy, gives a total useful life of only three seconds. Rather a short life for, let us say, a 12-inch gun costing $50,000 to $60,000. It is understood that the wearing here spoken of is not so much a mechanical abrasion as it is an actual burning of the metal by the intense heat of the charge.

E. G. Fischer, chief of the instrument section of the coast and geodetic survey, department of commerce, has just completed the design and construction of a signal lamp which will be used during the coming summer in the mountainous regions of Idaho and Oregon on primary triangulation where the distance between stations is frequently as much as 100 miles. This lamp has been tested by the bureau of standards and is shown to be more than 150 times as powerful as the acetylene signal lamps which have been used for a number of years by the survey. These acetylene lamps have been observed with the telescope over lines more than 120 miles in length. The new lamp is an electric one, with a specially designed filament, and the power is the ordinary dry cell.

By arranging channels in the crowns of the ends of open-hearth furnaces and connecting them with a compressed-air conduit, Regnier Eickworth of Dortmund, Germany, in a U. S. patent recently issued claims to prolong the life of a furnace by passing air through the channels so as to cool the crown and also exercising a cooling effect on the exhaust channels. The system is applied to both ends of the furnace, connected to a common compressed-air line with a reversing valve at the junction.

The 42-centimeter and other big guns, so often referred to in this war, are howitzers, of low velocity (say 1,000 to 1,500 feet per second) and using pressures in the powder chamber of about 14 tons to the square inch. The high-velocity naval and coast-defense guns have velocities of from 2,500 to 3,000 feet per second, and powder pressures of 18 to 20 tons per square inch. J. A. Longridge, the father of the wire-wound gun used so extensively by the English, stated many years ago that guns could be built to stand 30 tons pressure.

Many explosions have occurred in connection with oil firing. Practically these are true gas explosions, as liquid fuel is virtually converted into gas before burning. These accidents, states a writer in the *Vulcan*, have principally arisen in one of two ways. First, the oil is turned on and gasified during some appreciable length of time before lighting, so that the furnace is more or less completely filled in the meantime with an explosive mixture of gas, which is fired when the jet is lighted or when it is brought into a full flaming condition. Secondly, some part of the oil escapes the gasification process by reason of some defect in the burner, while the flame is burning more or less imperfectly, and the mixture is fired when the temperature of the flame is increased.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 2.

1,181,125. STEAM-BLOWER. Henry L. Erlewine, Marion, Ind.

1,181,240. AIR-PUMP-CONTROLLING DEVICE. Harry W. Munyan, Worcester, Mass.

1,181,325. AIR-PUMP. Harry W. Lockley, New Castle, Pa.

1,181,333. AUTO-AIR PIPE COUPLING. Charles H. Monroe, Carbondale, Pa.

1,181,347. AIR AND LIKE FLUID COMPRESSOR AND EXHAUSTER. Charles Leonard De Wilde Reader, Hursley, near Winchester, England.

1,181,373. GRAIN-SAVING DEVICE FOR THRESHING-MACHINES. Charles R. Daigh, Parsons, Kans.

1,181,374. AIR-COOLED HOLLOW SLAG-POCKET. George L. Danforth, Jr., and Samuel Naismith, Chicago, Ill.

1,181,450. APPARATUS FOR PRESSURE RELEASE. Hudson H. House and Charles E. Brunelle, Peekskill, N. Y.

1,181,459. BLOWER. Anton Kaltenbrunn, St. Nazianz, Wis.

1,181,492-3. MOLDING-MACHINE. Henry Tscherning, Freeport Ill.

1,181,515-6. APPARATUS FOR GASIFYING LIQUIDS. George A. Eynon, Cleveland, Ohio.

1,181,536. COMPRESSED-AIR MOTOR. John W. Oman, St. Louis, Mo.

1,181,584. INTERMITTENT TRANSMITTER FOR CARRIER-DESPATCH SYSTEMS. Merton L. Emerson, Braintree, Mass.

1,181,677. ART OF TRANSPORTING MATERIALS IN BULK. Thomas W. McNeill, Chicago, Ill.

1. The art of conveying small, solid articles, such as pickles, sauer-kraut, and the like, from a point of supply to a delivery chamber, which consists in, submerging the solids in a protecting liquid, the surface of which is exposed to atmospheric pressure, establishing an area of rarefaction, and alternately, first, closing the delivery chamber to the atmosphere and establishing communication thereto from the area of rarefaction, establishing communication with the supply beneath the surface of the liquid, and second, shutting off communication between the delivery chamber and the area of rarefaction and opening the delivery chamber to the atmosphere for contents delivery.

1,181,755. AUTOMATIC AIR-COUPLING DEVICE. Alfred B. Fitzgerald, Blackstone, Va.

1,181,886. AIR-MOISTENING DEVICE. James P. High, Fairview, Okla.

MAY 9

1,182,084. FLUID-COMPRESSION APPARATUS. Alan K. Gillespie, St. Louis, Mo.

1,182,089. AIR-PURIFIER. Henry J. Hert, Indianapolis, Ind.

1,182,094. ELEVATOR-INDICATOR. Alexis Le Blanc, New York, N. Y.

1. The combination of an elevator car and a pressure responsive device for indicating the position of the car and a flexible cord connected with the car, of a fluid containing receptacle communicating with the pressure responsive device, and means connected with and arranged to be actuated by the weight of the flexible cord for varying the pressure on the fluid in the receptacle as the position of the car is changed.

1,182,150. BLOWPIPE. James H. Downie, San Antonio, Tex.

1,182,215. PULSATOR FOR MILKING-MACHINES. Frank H. Schley and Clement F. Kimball, Council Bluffs, Iowa.

1,182,260. DOMESTIC VENTILATOR. John C. Fleming, Boston, Mass.

1,182,315. GENERATION OF POWER. JOHN G. ROBINSON, Melrose, Mass.

1. In combination, a reservoir, a plurality of tanks arranged above said reservoir, a pipe connection between said tanks and reservoir, an outlet pipe communicating with each tank, means for creating a vacuum in said tanks successively whereby continuous streams of water are caused to flow up and down said pipe connection and said outlet pipe respectively, an energy-translating device in said pipe-connection, an energy translating device in said outlet pipe, and means mechanically connecting said energy-translating devices, said energy-translating devices being simultaneously operated by the ascending and descending streams of water respectively.

1,182,343. COTTON-BOLL THRESHER. ANDREW J. BRYAN, Graham, Tex.

1. In a device of the character described, a pneumatic flue, a baffle plate separating said flue into two compartments, a toothed cylinder rotatably mounted in one of the said compartments, a breast coacting with said cylinder, and a bar carried by the baffle plate, said bar having guard pins cooperating with the toothed cylinder.

1,182,372. AIR-COMPRESSING PUMP. GEORGE I. HIPPLE, Chicago, Ill.

1,182,433. RESILIENT PNEUMATIC WHEEL. DAVID D. STONER, Cincinnati, Ohio.

1,182,460. APPARATUS FOR DISCHARGING DANGEROUS LIQUIDS AND GASES. ERNEST B. CRUGER, New York, N. Y.

1,182,507. AIR-COMPRESSOR. EDWARD A. RIX, San Francisco, Cal.

1,182,550. AIR-CIRCULATING MECHANISM. WILLIAM A. FREEMAN, Shreveport, La.

1,182,595. VACUUM-CLEANER. ALFRED J. STECKER, Detroit, Mich.

1,182,599. APPARATUS FOR MAKING HOLLOW RUBBER ARTICLES. HERBERT RALPH STRAUSS, Cleveland Heights, Ohio.

1. An apparatus for making inflated articles comprising air compressing mechanism and a separable mold adapted to occupy the air chamber of the compressing mechanism and be automatically closed and locked closed within the same.

1,182,624-5. HUMIDIFYING DEVICE. ALBURTO BEMENT, Chicago, Ill.

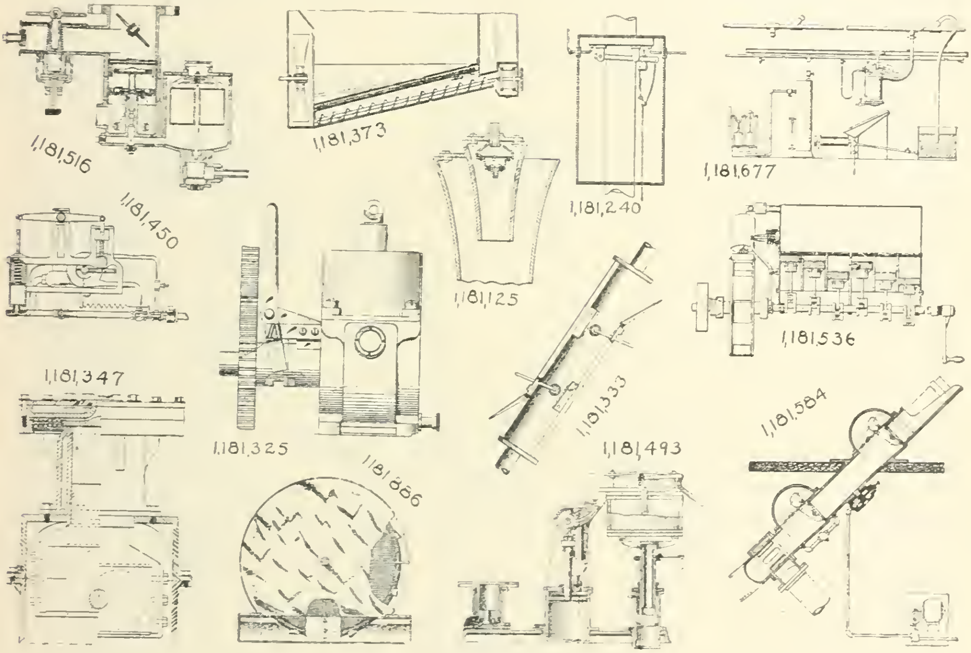
1,182,684. AUTOMATIC AIR AND STEAM COUPLING. DAN DUNBAR HOWE, Norfolk, Va., and GEORGE HOWE, Sparrows Points, Md.

1,182,774. AIR-PRESSURE BRAKE. PAUL KORT, Hanover, Germany.

1,182,811. MACHINE FOR GATHERING AND MOLDING GLASS ARTICLES. LEWIS STEELMAN, Millville, N. J.

1,182,836. AUTOMATIC TRAIN-PIPE COUPLING. LEWIS CLEAVLAND CARY, Los Angeles, Cal.

1,182,878. VALVE FOR GLASS-BLOWING MACHINES. WILLIAM E. STANDLEY, Pittsburgh, Pa.



PNEUMATIC PATENTS MAY 2.

MAY 16

1,182,937. SUCTION-VALVE FOR COMPRESSORS, ENGINES, PUMPS, AND THE LIKE. JAMES JOHN SMITH, Brisbane, Queensland, Australia.

1,183,031. INDICATOR FOR AIR-BRAKES. JOHN E. PRICE, Wilmington, Del.

1,183,063. AIR-CYLINDER-LUBRICATOR SYSTEM. WALLACE E. DUNKERLEY, CHARLEY A. MATTMILLER, and JOSEPH BRUNKER, Helena, Mont.

1,183,071. PNEUMATIC RELEASE DEVICE. JACOB W. KAISER, East Cleveland, Ohio.

1,183,077. COMPRESSOR. JOSEPH KOENIG, Two Rivers, Wis.

1,183,078. MARINE LIFE-SAVING APPARATUS. JOSEF KONRAD, Spokane, Wash.

1. In a marine life saving apparatus, a ship, an air tight habitable housing mounted on said ship, a buoy having an air intake and being free to remain on the surface as the ship sinks, and a hollow air supplying conduit connected

with said buoy and with the interior of said housing, substantially as described.

1,183,103. AIR-BRAKE APPARATUS. Spencer G. Neal, Los Angeles, Cal.

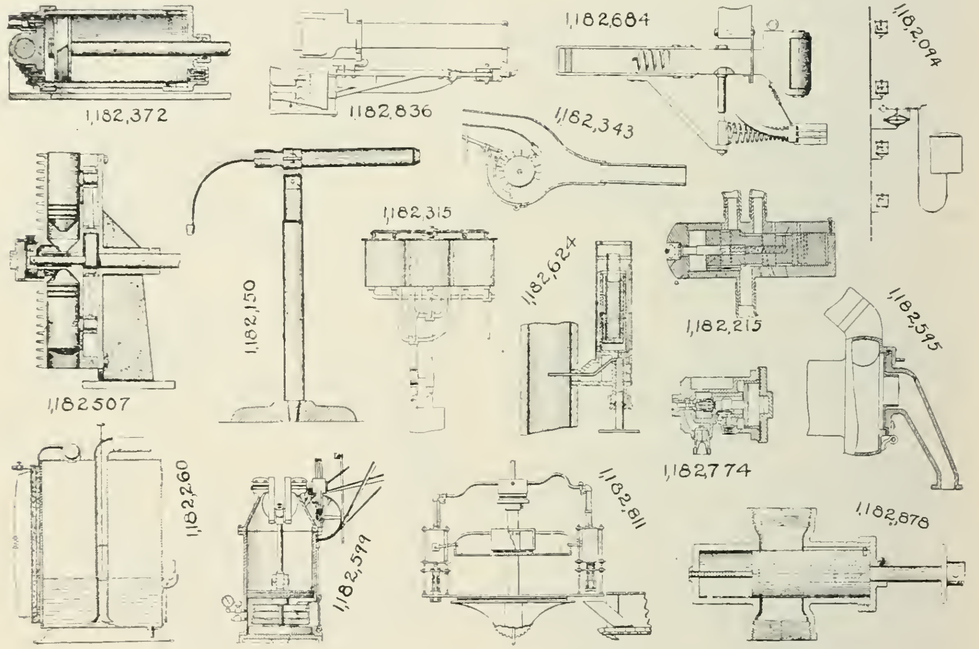
1,183,129. PORTABLE PNEUMATIC PUMPING APPARATUS. Howard Small, Atlantic City, N. J.

1,183,168. GOVERNING DEVICE FOR PNEUMATIC PIANO-PLAYER ACTION. Melville Clark, Chicago, Ill.

1,183,175. STEAM-PUMP OR AIR-COMPRESSOR. Kennedy Dougan, Minneapolis, Minn.

1,183,198. CARRIER FOR PNEUMATIC-DESPATCH TUBES. Burton U. Hills, Chicago, Ill.

1,183,274-5. ROCK-DRILL. Omar E. Clark, Denver, Colo.



Pneumatic Patents May 9.

1,183,412. FLUID-PRESSURE ENGINE. Alessandro Valente, London, England.

1,183,417. BLOWER DEVICE FOR CLEANING TUBES. Hermann Zeitz, Hamburg, Germany.

1,183,484. AIRSHIP. Edward Hunter Page, Covington, Va.

1,183,496. AIR - PUMP. Friedrich Albert Runge, San Marcos, Tex.

1,183,644. PNEUMATIC-HYDRAULIC GUN. Rollie Calvin Hill, Memphis, Tenn.

1,183,660. ROTARY FAN. Mary Mahan, Kansas City, Mo.

1,183,719. AUTOMATIC AIR - COUPLING. Charles H. M. Bird, Los Angeles, Cal.

1,183,727. PNEUMATIC WHEEL. Jose Greppi and Antonio Romanach, Buenos Aires, Argentina.

MAY 23

1,183,844. GAS - PRESSURE REGULATOR. Robert N. Baylis, Caldwell, N. J.

1,183,846. ROCK-DRILL. George R. Bennett, Denver, Colo.

1,183,859. AUTOMATIC PNEUMATIC TIRE-INFLATING MEANS. William S. Estle, New York, N. Y.

1,183,862. PNEUMATIC MOTOR. Charles Freborg, Kankakee, Ill.

1,183,912-3. ELECTROPENUMATIC BRAKE. Walter V. Turner, Wilkinsburg, Pa.

1,183,952. PNEUMATIC SWEEPER AND RENOVATOR. Alonzo E. Chapman, San Francisco, Cal.

1,183,998. HYDROCARBON-BURNER. James W. Marriott, Manayunk, Pa.

1,184,040. AIR-PUMP. Ira H. Spencer, West Hartford, Conn.

1,184,150. PNEUMATIC COTTON PICKING AND TRANSFERRING MACHINE. William M. Tulley, Corpus Christi, Tex.

1,184,172. PNEUMATIC MOTOR MECHANISM. Paris R. Forman, Chicago, Ill.

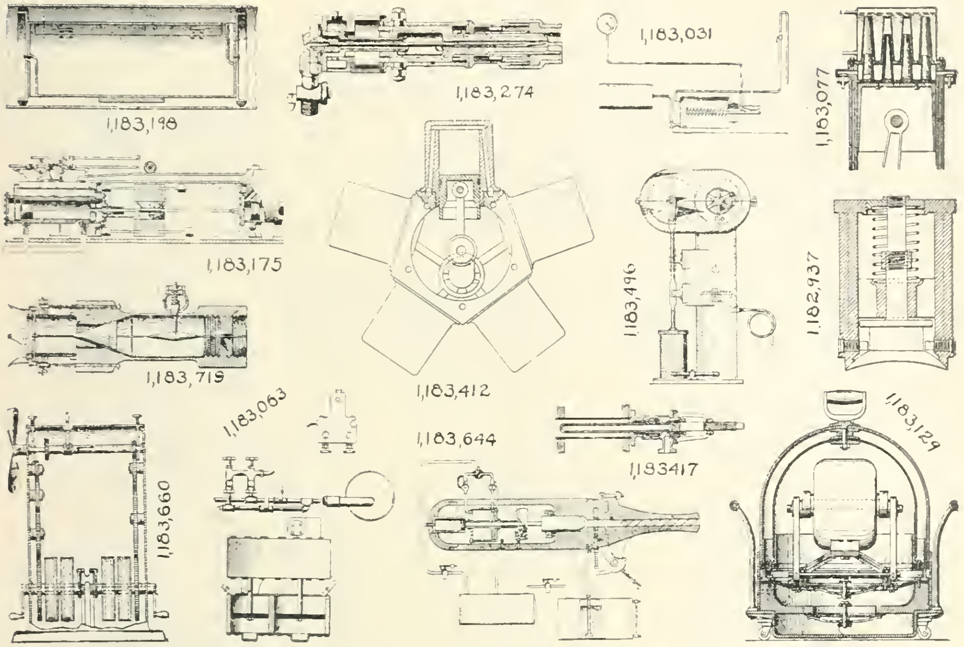
1. In a pneumatic motor mechanism, differential cylinders, each having a closed and an open end, a pair of spaced pistons respectively operating in each of said cylinders, each pair of said pistons being connected together through the open ends of the cylinders and to the part to be moved, the closed end of one of said cylinders being constantly in communication with a source of supply of operating medium through a port of large area, communicating with the cylinder at a point intermediate the ends of said cylinder, and also through a port of small area at the closed end thereof, and means for controlling the supply and exhaust of operating medium to and from the closed end of the other cylinder.

1,184,201. SUCTION-CLEANER. Henry C. Niemeyer, Racine, Wis.

1,184,249-50-51. PROCESS OF PRESERVING. George W. Luhrmann, Jersey City, N. J., and Robert Magrane, New York, N. Y.

1,184,252-3. APPARATUS FOR PRESERVING. George W. Luhrmann, Jersey City, N. J., and Robert Magrane, New York, N. Y.

1. An apparatus for processing foodstuffs and the like, including a retort, a steam supply, a compressed air supply, automatic means controlling said steam and air and adapted to maintain the interior of the retort at a predetermined



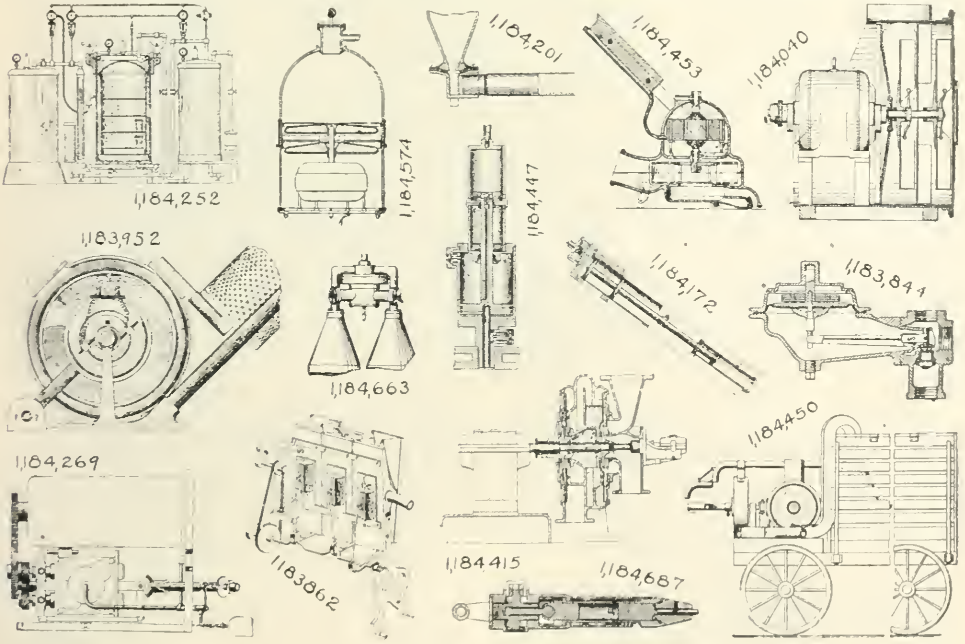
Pneumatic Patents May 16.

temperature and at an independent and predetermined pressure.

1,184,269-70. COMBINED PUMP AND STARTER FOR EXPLOSIVE-ENGINES. Frank E. Ten Eyck, Auburn, N. Y.

1,184,292. AIR-TORPEDO. Peter G. Wing, Chicago, Ill.

1,184,303. APPARATUS FOR FEEDING PULVERIZED FUEL. John E. Bell, New York, N. Y.



Pneumatic Patents May 23.

1,184,403. PNEUMATIC DUST - HANDLING SYSTEM. Whitford W. Woodley, Elizabeth City, N. C.

1,184,415. VACUUM-PUMP. John J. Brown, Newark, N. J.

1. A multiple stage vacuum pump unit comprising a casing a plurality of impellers and associated diffusers and walls within the casing dividing the same into compartments into one of which the liquid and gas are delivered from one impeller and its diffuser and passed to another compartment wherein they are permitted to separate and are caused to pass independently to the next succeeding impeller and its diffuser.

1,184,860. PNEUMATIC CONVEYER. Guido E. Lob, Chicago, Ill.

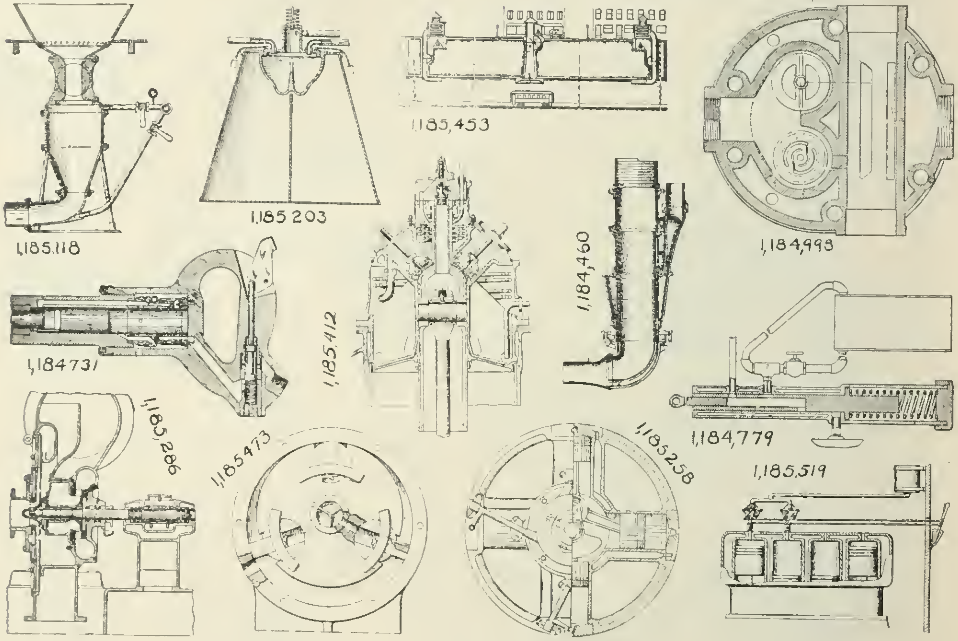
1,184,908. VACUUM CLEANING DEVICE. Morris S. Wright, Worcester, Mass.

1,184,953. AIR - SUPPLY - REGULATING MEANS. Harry F. Hitner, Mount Vernon, Ohio.

1,184,959. PNEUMATIC CLEANER. August C. Hummel, Milford, Ohio.

1,184,998. AIR-COMPRESSOR. Patrick H. Reardon, San Francisco, Cal.

1,185,103. PNEUMATIC CLEANER. Charles A. Killies, Syracuse, N. Y.



Pneumatic Patents May 30.

1,184,447. AIR-COMPRESSING APPARATUS. William P. Hammond, Passaic, N. J.

1. In an impulse pump, the combination of a power cylinder, a cushioning cylinder and a compressing cylinder, connected pistons in said cylinders, a valve-controlled inlet to the power cylinder above the piston therein, a passage affording free communication between the atmosphere and the cushioning chamber, and a valve-controlled passage leading from the power cylinder above the piston therein to the compressing cylinder below the piston therein, substantially as described.

1,184,458-9. VACUUM CLEANING-MACHINE. James B. Kirby, Cleveland, Ohio.

1,184,574. PNEUMATIC CLEANING APPARATUS. Oscar Andresen Schlesinger, Oakland, Cal.

1,184,663. STEAM VACUUM-PUMP. Abram H. Smythe, Alexandria, Va.

1,184,687. POWER-ACTUATED PNEUMATIC HAMMER. Louis E. Golly, Brooklyn, N. Y.

MAY 30

1,184,731. PNEUMATIC HAMMER. Frank M. Faber, Canton, Ohio.

1,184,779. AERATING FUEL-PUMP FOR EXPLOSIVE-MOTORS. James Shaw, Lodi,

1,185,117-8. MECHANISM AND PROCESS FOR MIXING AND TRANSPORTING CONCRETE AND SIMILAR MATERIALS. John H. MacMichael, Toledo, Ohio.

1,185,203 MILKING MACHINE. Victor B. Jordan, Waterville, Me.

1,185,258. PNEUMATIC CLUTCH. John Springer, Detroit, Mich.

1,185,286. AIR-PUMP. John J. Brown, Newark, N. J.

1,185,344. AIR-BRUSH. Joseph E. Philibert, Houston, Tex.

1,185,354. PNEUMATIC CARPET-SWEEPER. Benjamin C. Skinner, Berkeley, Cal.

1,185,392. AIR FACE-MASK. John M. Ganzer, Poughkeepsie, N. Y.

1,185,412. COMPRESSOR. Bernhard Kramer, Charlottenburg, Germany.

1,185,453. VENTILATING APPARATUS FOR SUBWAYS. John L. Walker, Coal City, Ill.

1,185,473. AIR-PUMP. John Buckley, Brooklyn, N. Y.

1,185,489. PNEUMATIC CARRIER. Merton L. Emerson, Braintree, Mass.

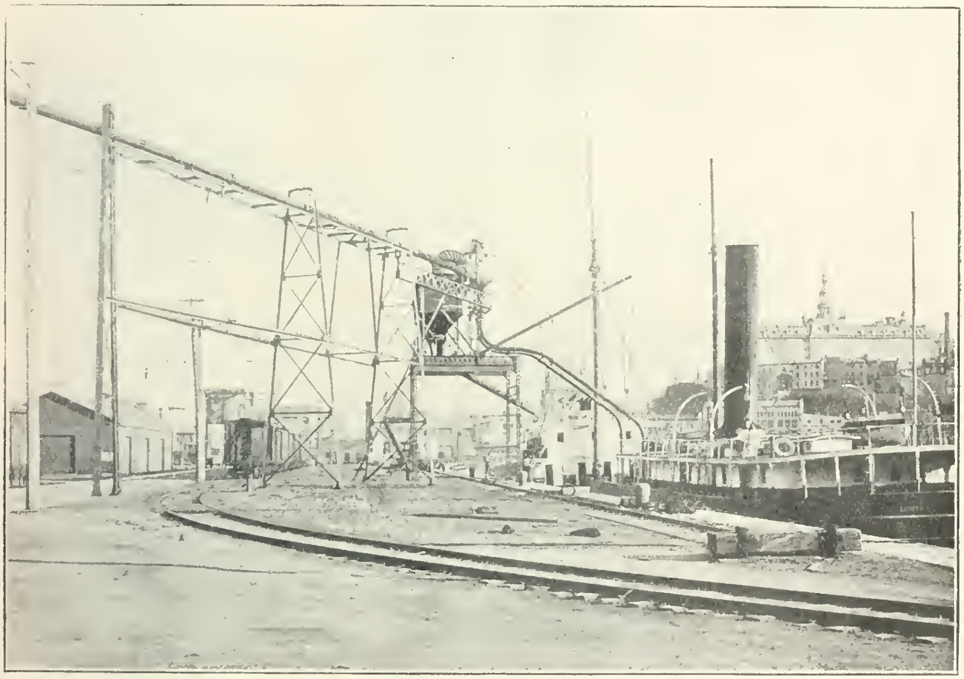
1,185,519. ENGINE-STARTER. Frank Marovitch, Nelson, British Columbia, Canada.

1,185,608. AUTOMOBILE AIR - SPRING. George Westinghouse, Pittsburgh, Pa.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XXI AUGUST, 1916 No. 8



PNEUMATIC GRAIN CONVEYORS

It will be remembered that in COMPRESSED AIR MAGAZINE for December, 1915, we gave some descriptions with illustrations of pneumatic grain conveying apparatus employed at Manchester and elsewhere in England. This pneumatic handling of grain in bulk is now successfully employed at various points in the United States and Canada as attested by the photos here reproduced which speak for themselves. These are taken from installations of The Pneumatic Conveyor Company, Old Colony Building, Chicago.

Fig. 1 shows a steamer lying at a dock in Quebec, Canada, with the unloading operation in progress. Fig. 2 shows the horizontal pipe line by which the grain is conveyed, and Richardson Elevator into which it is delivered. Fig. 3 shows the several hose immersed in the grain in the hold and rapidly sucking it up. The suction operation delivers the grain into the large tank seen upon the steel framing,

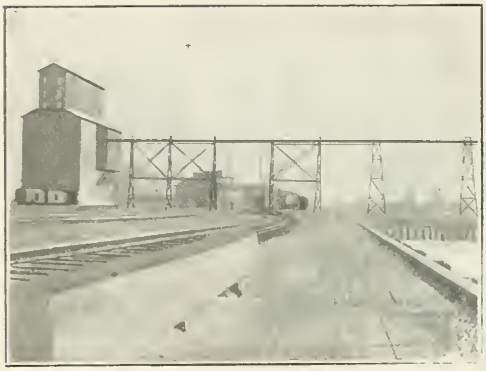


FIG. 2.

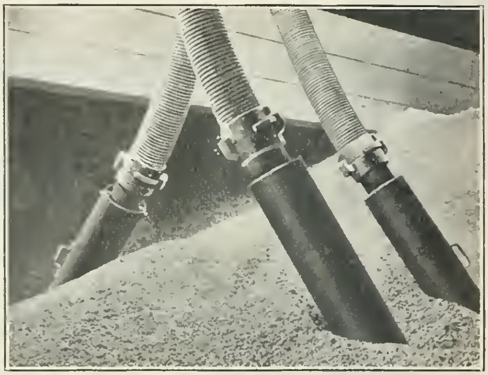


FIG. 3.

and then it is driven the remaining distance by air pressure.

The vertical lift in this case is about 90 ft. and the horizontal run nearly 700 ft. The grain entetring the elevator is received in a separate tank and air-locked down to the boot of the elevator lofter. The hose seen in Fig. 3 are 6 in. in diameter, corrugated, and very light and flexible. The operation is of course completely reversible, taking grain from the elevator and delivering it into other steamers as may be required. The plant has handled 4,800 bushels of oats per hour, discharging, and more than 6,000 bushels loading. The horse power consumed on this long line averaged about 2 H. P. per ton hour.

Six men are required in the boat and one on deck, with the regular house crew in the elevator. These six men, at this particular site, are required by the Longshoreman's Union, as the minimum in any boat. Two men in the boat are all that is necessary for about 75 per cent. of the cargo.

Fig. 4 shows a pneumatic marine lift dis-

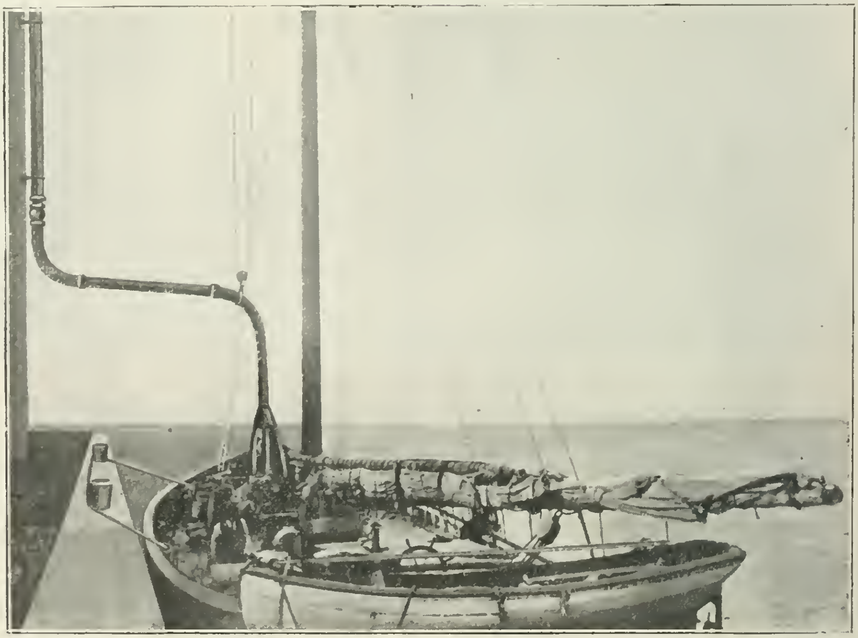


FIG. 4.

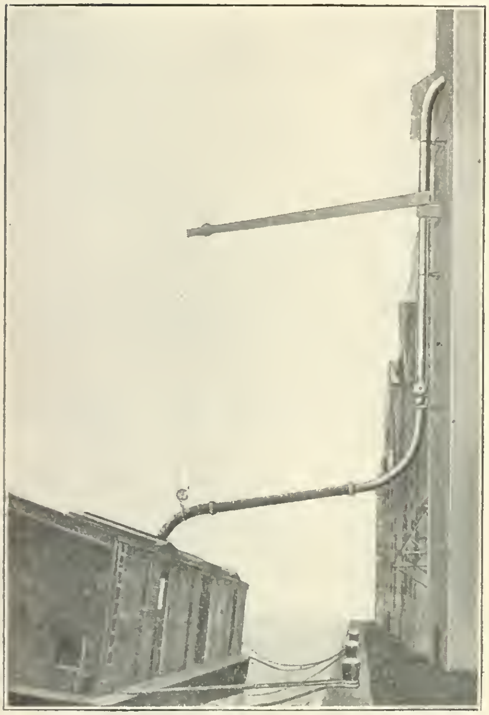


FIG. 5.

charging grain from a Bay boat at the Western Maryland Elevator, Baltimore, Md., and Fig. 5 shows the same lift discharging from a covered scow. The total vertical lift of this installation is 80 ft., with a horizontal carry one length of the boom. The grain is discharged directly into a receiving tank and from there is air locked to the bottom of the relift lofter. The exhauster is of the positive pressure rotary type, driven by motor through silent chain, and is placed on the dock floor.

The conveying pipe is carried down the outside of the tower, and the inland vertical leg of the swinging arm telescopes into this fixed pipe, so that the manifold with the several hose attached can be raised and lowered to accommodate boats of different sizes and their cargoes. The swinging arm is carried both to the inland and the water end by cables, and is operated from motor driven hoists within the tower.

The capacity of this installation is 2,500 bushels of wheat per hour, and it consumes slightly over 1¼ H. P. per ton hour.

WELDING JOINTS IN GAS MAIN CONSTRUCTION

The following paper by F. L. Hadley, Superintendent of Lines, Peoples Natural Gas Company, Pittsburgh, Pa., read before the Natural Gas Association, should be of special interest to the installers and users of compressed air. Welded piping both for natural gas, as dealt with in this paper, and for artificial illuminating gas is rapidly superseding all other types of pipe connection, but has not made as rapid progress in compressed air service for which it would seem to be specially adapted. It is cheap and rapid in application and is especially desirable for the elimination of all leakage. It is no more difficult to have tight piping for air than for gas, water or steam, but the air has not the same insistent habit as the others of making its escape immediately known, and so air leaks are apt to go undetected, but pipe welding is tight pipe insurance, and in these days should be generally adopted.

The subject which is treated in this paper is one which has become of great interest to all gas men and especially so to those interested in the construction and maintenance of lines and the transportation of natural gas from the field to the different markets.

From what we now know of the oxy-acetylene method of welding pipes together it appears as if the ideal method of constructing natural gas mains has been discovered and that it will mean as great a boom to the natural gas industry of the future as the discovery of the coupling was to the past, and while it is true that this method may not lead to the building of as many long lines to reach distant markets as did the development of couplings used in connection with plain end pipe, yet it will mean that the leakage as being one of the principal factors in the transportation of gas will be practically eliminated, effecting a saving of many thousand dollars annually to all of the large gas companies, besides giving us cheaper lines to build and operate.

This method of laying lines has been tried out very extensively by artificial gas companies during the past few years and in all cases of which we have knowledge it has been found to be very successful both in economy and in securing good tight lines. Some of the eastern companies are now welding all their extensions, including the mains and service lines down to ¾-in. pipe. At the time which this paper is written the writer is engaged in installing such a plant which will consist of 14 miles of 8-in., 9 miles of 6-in. and approximately 10 miles of smaller pipe together with several hundred service lines of ¾-in. pipe all of which is to be welded, it being our intention to complete the entire plant without the use of a single fitting of any kind, with the exception of valves and stop cocks.

WELDING 7.5 MILES OF 10-IN. PIPE

The writer desires to give his experiences in building approximately 7½ miles of 10-in. line during last fall on which this method of joining the pipe was used in place of couplings or collars. This line was laid through rolling country with the highest hills of probably 300 ft., being in some sections somewhat rough with a number of small ravines. The pipe used was standard 10-in. I. D. line pipe furnished in long lengths which averaged about 35 ft. to the joint. In order to facilitate the welding we had the ends of the joints chamfered or beveled at an angle of 60 deg. which was done in the pipe mills without extra charge. By having the pipe thus chamfered the welder was able to start welding at once after the joints were lined up, otherwise it would be necessary that he melt down the edges of the pipe with the flame to secure a foundation before he would be able to start welding.

Heretofore in laying welded pipe we found that it was customary to lay the pipe in sections along the ditch and by turning the joints by means of tongs to allow the welding to be done on top of the pipe. We decided to make a little departure from this method and wherever the ground was suitable we laid the pipe joint by joint directly over the trench and did the welding without turning the pipe. While the welding was somewhat slower by reason of it being necessary to weld underneath the pipe, we found that we gained time in the end as we were able to slack the pipe directly into the ditch after the welds were made and to make the bends the same as if we were laying sewer pipe; that is by building fires and heating the pipe wherever it was found necessary to place a bend.

Owing to the rough character of the ground, we were obliged to make a great number of these bends, but in nearly all cases they were made as the welding progressed. In a few places we had men go ahead and make bends which were placed in the line when the welder came up but as a rule this was only to gain time in some certain rough section of ground.

TESTING THE JOINTS

In testing out this line we used 100 lbs. of gas pressure from one of our compressor stations and when completed was found tight with the exception of 5 leaks which were very small, being nothing more than little pin holes in the welds. These leaks can be easily repaired by placing additional metal upon the weld after the pressure has been taken off from the line.

During the laying of the line we subjected it to many severe tests in order to find out the strength of the welds and in only one case were we able to break them. For instance we would hold the pipe up to the top of the trench with one of the wooden horses and lower it into the ditch on both sides of the horse, then we would suddenly let go of the pipe and allow it to fall without any support to the bottom of the trench, then at other times we would leave 5 or 6 joints swinging in order to test the strength of the weld. We would make the bends in some cases nearly at the weld but at no time did we have any trouble with them not holding although the strain was very great where the bends were made without the line being blocked or braced. In fact we tried out the strength of the welds in every possible way in order to find out if there were any weak points in the construction of a welded line. In other words we did not want to give up the idea of welding our lines in the future unless it was proven to us that it was not practicable.

This one break which we had during the building of the line was caused by a poor weld, the pipe not being perfectly joined together although at a casual glance it had the appearance of being as strong as any of the other welds; yet upon a more careful examination we found that the two pipes had been simply tacked together with metal and the iron melted in between them without being united and making a continuous pipe. Fortunately for us the welder who made this weld was discovered in time, otherwise we might have had more trouble with defective welds.

CONTRACTION AND EXPANSION

Before and during the building of this line there was considerable discussion as to the contraction and expansion on a welded line of this length, many holding that the line would pull apart at the welds owing to the contraction and expansion that they expected we would find on a line such as we were laying with only 20 in. of covering, that being the depth which we were having it buried. However we did nothing to take care of this as we took it for granted that the pipe itself would take care of any contraction or expansion that that there might be. In other words, we figured that when the line was finished we would have one continuous joint of pipe the same as if we had secured a 7-mile length from the mill and if it had been possible to secure such a joint of pipe nobody would have thought it necessary to have it cut and expansion joints or sleeves put in.

In this connection I can advise you that we have not had the slightest trouble with the line pulling apart, although there has been some severe cold weather since the line was put in commission. There have been two breaks, the first one shortly after the gas was turned into the line, which upon examination showed plainly that it came from a defective weld in which the pipe had the appearance of being burnt. The other break was caused by a sink in the surface of the ground at a coal mine and was a break which would have occurred on any line under like circumstances. Neither of these breaks showed any signs of there being contraction of the pipe, although the break at the mine took place during very cold weather.

COST

To secure welders we were obliged to pay a rate somewhat higher than the regular rate, yet with this high cost of labor the cost of the welds came slightly under the price of standard couplings such as is generally used on like lines, but this being our first experience in this kind of main line construction our costs were likely greater than they would have been had our experience been more extensive. I believe that a welded line can be laid with such economy that the cost of the joints will not be over two-thirds of what it would be if couplings were used.

WELDING WELL CASING

It might be of interest to the members of the association to know that during the time which we were engaged in laying the line above mentioned that we tried out oxy-acetylene welding on casing at one of our wells known as the R. A. Geary well or as it is more commonly known now, "The Deep Well." This well, on which we began work in November, 1911, is located about 4 miles out of McDonald, Pa., and at the time this paper was written had reached a depth of 7,181 ft., being by far the deepest well ever drilled in this country and only exceeded by one other well in the world. At the time of which I write we had in the well a string of 3½ in. I. D. or 4½ in. O. D. casing 6,320 ft. long with heavy collars.

In order to use a larger sized casing it was decided to pull out the screw pipe and run in a string of 5 in. with welded joints. The casing was furnished in 21 to 23-ft. lengths, the first 2,000 ft. being 5-in. O. D. or 4.29 in. I. D., 0.355 in. thick, weighing 17.611 lbs. per ft. Owing to the fact that there was an enormous water pressure on the lower casing it was heavier than that used above the water, which was 5 in. O. D. or 4.24 in. I. D., 0.288 in. thick, weighing 14.493 lbs. per ft., there being 4,320 ft. of this or a total length of 6,320 ft. in the string. On both weights the ends of the joints were chamfered 60 deg.

In placing the casing in the well there were two joints welded together outside of the derrick, then after the welding was completed these were placed in the hole and lowered down until only about 5 ft. remained above the derrick floor. Then two additional lengths were welded together in the yard as before and then brought into the derrick, raised and suspended in the air with the lower chamfered end resting upon the upper chamfer of the section previously placed in the well, then the welder proceeded to weld these sections together vertically, after which they were lowered into the hole.

In order to sustain as much of the weight as possible during the time that the casing was put in, a shoe was placed in the casing, this being an oak plug about 3 ft. long which was driven into the end of the first joint. It was the intention to drill this plug out after the casing had been placed; but when about ½ mile of pipe had been lowered into the hole the pressure of the water was so great that the plug blew out with great force. After this happened a second plug was placed in the next section; this plug likewise was of wood, but it also had a steel ring back of it. When all the casing had been placed in the well this plug was drilled out leaving the casing free. When you realize that this string of pipe 6,320 ft long with a weight of over 48 tons was to a great extent held by the last weld it will give you a very good idea of the strength of a properly made weld.

Before closing, I might say that we exercised great care in being sure that more metal was used at the weld than there was in the pipe itself. On this line we made it a point to have at least 1-10 in. more and on the casing sometimes more probably ⅛ to 3-16 in. The strength of the weld depends wholly upon the amount of metal used and the care taken in welding the two together.

ENGINEERING EXPLOSIVES

Nitro-glycerine is a limpid oil formed by the action of a mixture of nitric and sulphuric acid upon ordinary glycerine. This chemical action is a violent one unless carefully controlled. After it has taken place, the nitroglycerine is washed repeatedly to remove any trace of acid that might remain. The presence of acid is dangerous in the finished explosive because it may produce a chemical action of disastrous results. For practical use, the liquid nitro-glycerine is so sensitive to percussion and friction that it is dangerous to transport it or attempt to employ it alone. However, when nitro-glycerine was first introduced for driving the Hoosac tunnel in Massachusetts, and for springing oil-wells in Pennsylvania, it was used alone, being carried in copper cans and loaded in tin tubes. In the oil-well region, men made an occupation of driving a horse and light wagon through the country for carrying the pure nitro-glycerine to the consumers. Many accidents were reported, and a carrier's position was scarcely to be envied.

Later it was learned to mix the nitro-glycerine with a quantity of kieselguhr, an infusorial earth composed of the silicious skeletons of minute diatoms, and therefore called diatomaceous earth. The nitro-glycerine is absorbed by the earth, which is itself inert and simply forms a plastic mass that can be more safely handled than the nitro-glycerine. Another advance came when it was found that nitro-cellulose, or gun-cotton, could be dissolved in the nitro-glycerine to form a nearly uniform jelly. This mixture constitutes blasting gelatine. The gun-cotton is made by the action upon cotton fibres of the same acids as are used in the manufacture of nitro-glycerine, great care being taken to wash away all trace of excess acid. When gun-cotton, or nitrocellulose, is incorporated with the nitro-glycerine, it shares in the explosion, instead of acting as an inert base like kieselguhr. Thus additional power is gained. Blasting gelatine, then, is a mixture of two complex compounds, which fact increases the possibility of chemical change with consequent deterioration and danger. Blasting gelatine contains 92 per cent. nitro-glycerine and 8 per cent. nitro-cellulose There are, also, various intermediate mixtures of nitro-glycerine and nitro-cellulose with a proportion of wood meal and potassium nitrate, the object being to produce effects intermediate between straight dynamite and blasting gelatine. When such a complex mixture was attempted, it was at first difficult for any mechanical method to render a perfectly homogeneous mass, but later methods of manufacture have improved this.

The initial pressure of the different explosives when detonated in their own volume are as follows: straight dynamite (nitro-glycerine mixed with an inert base) 80 tons per square inch, blasting gelatine 113 tons, gun-cotton 71 tons, black powder 21 tons. It is evident that blasting gelatine is the most powerful. Likewise it has the highest rate of detonation, 25,262 ft. per second, as against 22,368 for straight dynamite and 984 for black powder.—*Mining and Scientific Press.*

A PULMOTOR IMPROVEMENT

The Draeger Oxygen Apparatus Co., Pittsburgh, has developed a new valve for portable, hand-operated pulmotors which is said to control the air pressures producing inhalation or exhalation of the patient's lungs. The pressure control valve is in the hands of the operator, who is at the patient's head—not at the pump. The operator moves the lever back and forth to obtain uniform inhalation and exhalation, timing these with his own breathing. The man at the pump produces only the amount of air desired by the operator and maintains this by occasional strokes, as necessary. A pressure once obtained is maintained until the operator releases it. Indicating gages located near the valve show the first symptoms of the return of natural respiration to the patient and enable the operator to time his efforts with the patient's breathing.

INDUSTRIAL PREPAREDNESS AND THE ENGINEER

BY WILLIAM L. SAUNDERS

[The following is a small portion of an article with the above title which is the leading paper in Engineering Magazine for July.—Ed. C. A. M.]

Coal, iron, and factories, if organized and mobilized, are real sources of military supremacy, just as much so as they are the sources of industrial supremacy in peace. Just as the human element has had to give way in its effectiveness to machinery, so has the valor of the soldier taken second place in importance to the volume of munitions. The causes which brought about the change in both cases are identical; and it seems plain that it is mainly because the Allies have increased and standardized their capacity to supply munitions, and because they have had the aid of the industrial resources of the United States, thus bringing them to a point quite equal to the resources of Germany, that the present war promises to result in a draw. Were Germany fighting Russia and France alone, her preponderance of resources would have enabled her to crush them.

Having called attention to this situation, the natural question is, What is the remedy? Is it not plain that we need first an organized and centralized direction of our mines and industries? The government of the United States should not look to the ownership, but to the organization and direction and encouragement of these assets. It should stop waste by providing for cooperative work and even for combinations among all the natural resources of the country. Through proper supervision and direction, the owners of these natural resources should be permitted to make fair profits in the direction of efficient production and contrary to the scattered and now uncontrolled system of waste. The most valuable things which Nature has given us are in a disorganized condition, working at loose ends, operated with the objective in view of profit during the lifetime of the present generation only.

The question naturally arises: How shall this supervision and direction be accomplished? The answer is already given in the organization of the engineers of the country. At the request of the President of the United States, five National Engineering Societies, acting under the direction of the Naval Consulting Board, through its Committee on Industrial Preparedness, have organized boards of engineers in each state and territory. These engineers, who belong to and who have been selected by their respective societies, are at work now upon a plan of industrial preparedness. Here we have a board of five engineers in each state and territory; these men in turn have at their command all the members in good standing of these five societies, comprising more than thirty thousand engineers, who have been called upon as field aids. This professional, nonpartisan organization is unique in our history. Nothing like it has ever been known before. The usefulness of such an organization can scarcely be measured. It should be made permanent. Who but the engineer is qualified to do effective work looking to the conservation of our natural and industrial resources? The engineer is an executive through training and experience. It is he who has built up these great industrial resources, hence we are safe in asking him to take care of them. Engineering has been defined as the art of organizing and directing men and of controlling the works of Nature for the benefit of mankind. He works for reputation and results rather than for profit. His aim is to accomplish the best result in the most economical manner, for this is the best engineering. He is engaged in analyzing and putting to practical service the hidden forces of Nature.

Let the Government and the Congress take heed to the advice of this splendid body of professional engineers, and let them do something more than merely tabulate our industries. They should stand as a reliable body to bring Government and business closer together, not on special, but on broad, general lines. Through this organization let the politician and the business man cooperate for the present and future safety and prosperity of our industries and for that measure of peace in the nation, the enduring nature of which now passeth all understanding.

Forty-seven large manufacturing concerns at Oshkosh, Wis., on July 1 put into effect the "extra daylight" plan by permitting all employees to start and finish work an hour earlier. This is the sensible and proper way of doing it, much better than monkeying with the clocks of the whole community.

ARTIFICIAL ICE IN CANADA

An effective illustration of the progress which has been made in the economics of artificial ice manufacture is found in the fact that a large and long established Canadian firm, the Lake Simcoe Ice Company, of Toronto, can see prospective profit in the installation and operation, night and day, of an up to date ice producing plant. The company may be assumed to be fully informed as to the possibilities of profit in the undertaking, having been formed forty years ago and now harvesting natural ice in large quantities at Lake Simcoe.

The manufacturing plant is not intended to interfere with the supply of natural ice but is to be regarded as an auxiliary. With natural ice there are various losses or expenses involved, such as first handling and conveyance, breakage, melting and storage, which disappear or are much reduced when the ice is manufactured. The artificial ice also is perfectly and uniformly clear and pure and more readily marketable.

The plant has a capacity of 75 tons of ice per 24 hours and embodies all the devices known at the present time for producing ice of the best quality and at the lowest cost. The main unit of the plant is an 18 by 28 in. York vertical, single acting, belt driven, ommonia compressor, driven by a 200 h. p. Canadian Westinghouse, slip ring motor. The ice is frozen in galvanized iron molds surrounded by brine. Each mold is 11½ by 22½ in. by 60 in. deep, and will make a cake weighing 400 lb. The water for filling the cans is filtered and precooled, first by passing through coils of galvanized pipe covered with the waste ice from thawing, and later in a storage tank where it is cooled to 38 or 40 degrees before passing into the cans through the automatic can fillers.

COMPRESSED AIR TO MAKE THE ICE CLEAR.

Although only the purest filtered water is used in the plant, the ice can only be made transparent by keeping air blowing in the cans, and thus keeping the water in motion during the freezing process. This is accomplished by means of a small brass tube which passes down the side of the can and allows the air to blow in near the bottom. While the ice is freezing, this brass tube is connected to the air pipe in the framework of the floor by a rubber tube, which is disconnected when the ice is ready to be lifted out. A galvanized iron perforated plate called a grid is suspended about the level of the water in the cans, and as the ice freezes, it expands and the water rises above the grid a few inches, in which collects any sediment in the water thrown out in the freezing process. This portion of the ice cake above the grid is thrown away after thawing and the grid makes a perfectly square top to the cake and makes all cakes of a uniform height.

The air for this purpose is first taken through a hood from the outside atmosphere and passed through a "Gardner" 10 in. by 12 in. horizontal, double acting, air compressor, equipped with unloader device for maintaining forty pounds pressure. The compressor is driven by a 20 h. p. Canadian Westinghouse motor and discharges into an air receiver 5 ft. diameter by 18 ft. high. After leaving the receiver the moisture is removed from the compressed air, first by passing it through a double pipe cooler made of 2 in. and 3 in. pipe, then through a shell and coil brine cooler in which brine is circulated by means of a small centrifugal pump from the freezing tank. The cold dry air thus obtained then passes through a reducing valve which holds a constant pressure of about twenty-five pounds on the laterals and connections which distribute the air to the cans. This air system, which is of the highest importance for obtaining clear ice is equipped with, in addition to the unloader on the compressor and the automatic reducing valve, electrical alarm gages which give the operator ample warning in case any of the automatic devices fail to work

THE UNIQUE LA BREA FOSSIL BEDS

G. Allen Hancock has given to the city of Los Angeles, Cal., thirty-two acres of La Brea ranch, the section in which excavations have been made for the past three years, provided the land be improved and a museum established. The La Brea beds have produced thousands of perfect skeletons of birds and quadrupeds that have inhabited this section for the past 200,000 years. It appeared as though the bones had been placed in the huge asphalt pits by hand so perfectly were they piled. In one small space sixteen imperial elephant skeletons were found.

AIR-LIFTS AT A CYANIDE PLANT

BY PAUL W. GABELEIN*

At the cyanide plant of the Baker Mines Co., Cornucopia, Ore., the pulp, both sands and slimes, is handled entirely by air-lifts. In the following brief description, two of the air-lifts are taken up in detail and illustrated, the first handling sands and the second slimes pulp.

The ore, after being crushed in stamps to 25-mesh, is classified in a duplex Dorr classifier, the sands being lifted by air to the leaching tanks and the slimes being treated in three Dorr agitators 20 ft. diameter and 16 ft. deep, three Dorr thickeners, and a Portland continuous filter. The plant has three air-lifts for pumping sands and slimes, and compressed air is also required for the operation of the Dorr agitators and the filter.

Compressed air is supplied by a Sullivan compressor, class WG3, belt-driven, size 14x12 in. This compressor is operated at 120 r.p.m., and at 5,000 ft. altitude has a capacity of 215 cu. ft. per min. Air is compressed to 15 lb., which is sufficient for the operation of the air-lift system. The power consumption under these conditions is 12.5 hp.

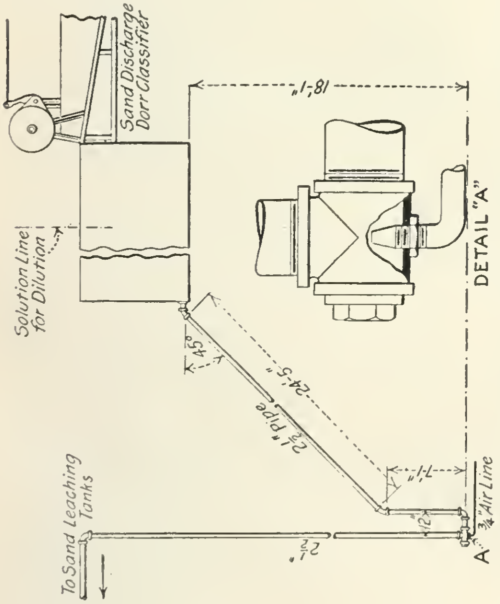


FIG. 1. DETAILS OF SAND LIFT.

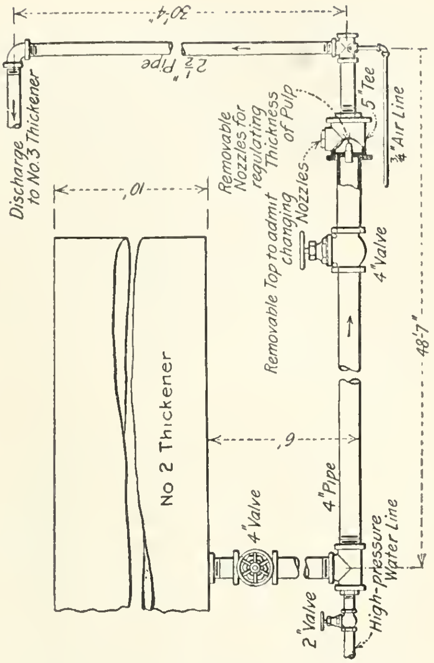

30'4"
2½" Pipe
Discharge to No.3 Thickener
10'
Removable Nozzles for regulating Thickness of Pulp
5" Tee
¾" Air Line
Removable Top to admit changing Nozzles
4" Valve
48'7"
No 2 Thickener
6'
4" Pipe
4" Valve
High-pressure Water Line
2" Valve

FIG. 2. AIR LIFT FOR SLIME THICKENER.

Fig. 1 illustrates the sands lift. As the sands are discharged from the Dorr classifier, they drop into a mixing box in which they are diluted with barren solution in the proportions of 4 of solution to 1 of sand. This rate of dilution has been found satisfactory both for the successful operation of the air-lift and the automatic distributors with which the leaching tanks are equipped. The sketch shows the construction of the lift in detail. The amount of sand handled per day is 40 tons, diluted with 160 tons of barren solution. Fig. 2 illustrates the air-lift between No. 2 and No. 3 thickeners. The situation of No. 2 thickener is such that it requires a rather long pipe line to transfer the pulp to a point from which it can be lifted to No. 3 thickener. The lift is rather a high one, owing to the fact that No. 3 thickener is at sufficient elevation to allow the pulp to flow by gravity to the filter-stock tank and thence to the filter. The slimes handled are very fine and colloidal. Fig. 2 gives the air-lift in elevation. It handles approximately 25 tons per day of slimes at a dilution ratio of 1 :1, or 50 tons of pulp per day. The thickness of the pulp delivered by the thickener is regulated by placing nozzles of various sizes in a reducer placed as shown in the sketch. The reducer is from 4 to 2 in., and the nozzles are 2-in. plugs drilled through the top. Each thickener is equipped with a set of nozzles, and these are changed as the flow of pulp demands.

---

*Mill superintendent, Baker Mines Co., Cornucopia, Ore.

While the air-lift system of handling pulp is not the most efficient, it has numerous advantages over the use of sand and slime pumps. Some of these advantages are low first cost, simplicity, absence of repairs, avoidance of delays due to repacking and repairing pumps and practically continuous operation. The system at the Baker Mines Co.'s plant has given satisfaction and practically continuous service.—*Eng. & Min. Journal.*

DANGEROUS MINE GASES

George A. Burrell and Alfred W. Ganger, of the Bureau of Mines, recently examined a number of Cripple Creek mines to gather data regarding the composition of gas that issues from the rock into the mines of that district.

In summing up their observations they say that the escape of gas from the rock strata into the mines of the Cripple Creek mining district is a menace to life and to mining. The outflow of this gas, supposed by Lindgren and Ransome of the Survey to represent the last exhalations of the extinct Cripple Creek volcano, is largely influenced by outside atmospheric pressure, because it is confined in the rocks under very low pressure.

At a few mines a pressure system of ventilation has been installed to assist the ordinary natural circulation. Under this system air is blown into the mines by a fan placed at the top of the shaft, thereby placing the mine workings under a little pressure, at some places equivalent to 6 or 7 ins. of water (about 0.5 in. of mercury). This method assists very materially in keeping the gas forced back in the rocks.

All told, 32 samples of mine gas were collected from four mines.

It was impossible to secure samples of pure rock-strata gas as it issued from the rocks during inspection of the mines, hence entrance was made as far as it was possible to penetrate into some of those drifts that were most contaminated with the gas. A sample containing 2.69 per cent. of oxygen (sample 760, Cresson mine) was obtained and was the sample containing the largest percentage of the rock-strata gas. Undoubtedly if one had been able to penetrate 15 or 20 ft. farther into the drift a sample practically devoid of oxygen would have been secured.

A number of samples that contained the smallest percentages of oxygen were recalculated air-free, in order to determine the actual composition of the gas as it issued from the rocks. This calculating showed that the gas contained between 12.03 and 18.37 per cent. of carbon dioxide and 81.63 and 87.97 per cent. nitrogen. The average of all the results was 13.87 per cent. of carbon dioxide and 86.13 per cent. nitrogen, or, in round numbers, 14 per cent. of carbon dioxide and 86 per cent. of nitrogen.

The gas, then, as it occurs in the rocks is a mixture of carbon dioxide and nitrogen with the latter much in excess.

The bad effects on life and lights are principally due to the fact that the rock gas so dilutes the air of the mines that the oxygen therein falls to a point where lights will not burn or so low that life is endangered.

Symptoms of distress in men do not usually begin to appear until 3 or 4 per cent. of carbon dioxide is present, when the breathing becomes affeceted. Men can go on working for a considerable time in such an atmosphere although they will certainly become more quickly fatigued. Carbon dioxide affects the so-called respiratory center in the brain and makes a man breathe a larger volume of air over a given time than if no carbon dioxide were present. While air with so small an amount of carbon dioxide as 2 per cent. may be breathed with comparative safety and no great discomfort, at the same time the efficiency of the workmen is lowered. In addition to the work a man may be doing in such an atmosphere he is handicapped to this extent: He is forced to breathe a larger volume of air over a given time, a feat that consumes energy just as his work of drilling a hole in the rock or loading ore consumes energy. In England the Coal Mines Act requires that the carbon dioxide shall not rise above 1.25 per cent. in any part of a mine.

When the oxygen in air is gradully reduced very little effect may be noticed before the occurrence of impairment of the senses and loss of power over the limbs. If the reduction is gradual and the symptoms carefully watched it will be noticed that at about 12 per cent. of oxygen (that is, with a reduction of about 9 per cent. from the composition of atmospheric air) the respirations become just perceptibly deeper and more frequent, and the lips slightly bluish. Distress increases with continued decrease of the oxygen until with 6 or 7 per cent. there is marked clouding of the senses and loss of power over the limbs, which would end sooner or later in death. In a test similar to the above that the senior author participated in, a man lost consciousness when the oxygen dropped to about 7 per cent.

As the oxygen in air decreases the illuminating power of lights diminishes, until in the case of the ordinary oil-fed lamp wick such as a candle or miner's oil torch or safety lamp, the flame becomes extinguished at about 17 per cent. of oxygen, and the acetylene flame at between 12 and 13 per cent. of oxygen, *i. e.,* if a candle flame goes out the oxygen content of the air is less than 17 per cent., and if the acetylene flame goes out the oxygen content is less than between 12 and 13 per cent. This effect is almost entirely due to the oxygen content and even in the Cripple Creek mines where the carbon dioxide may be from 5 to 10 per cent., in atmospheres that extinguish flames, it exerts only a minor effect.

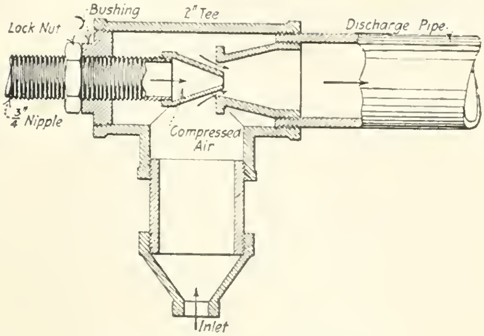
Men should not work where candles will not burn, and should not be solely reliant upon the acetylene flame for guidance regarding bad air. The acetylene flame will burn in air where the oxygen is only a few per cent. above the proportion that is very dangerous to life, hence only a small margin of safety is assured.

Eight of the samples contained traces (0.01 to 0.03 per cent.) of combustible gas, apparently methane (CH_4). The proportions were so small, however, as to be insignificant.

AIR SIPHON FOR CLEANING GAS RETORTS

BY H. C. MC DERMID

An unusual method was employed recently to remove brick dust and chips from a large bank of gas retorts. The device used was a roughly built vacuum cleaner operated by compressed air. As the diagram shows, it was made of a 2-in. tee with a portable bushing and ¾-in. pipe screwed in one end. The nipple on this pipe was threaded over its entire length of 6 in. and was drawn down to a small opening. This small end was reamed out to a smooth finish by a taper reamer, leaving an outlet about ¼ in. in diameter. When its proper position had been determined this pipe was secured by a locknut.



FOR CLEANING GAS RETORTS.

At the opposite end of the tee a short 2-in. nipple was screwed in place, its inner end forming an orifice with inside diameter of 1 in. and about 1 in. from the end as shown. To the branch of the tee was screwed a short 2-in. nipple having a ¼-in. opening. The device is really an air siphon.

In practice the discharge pipe was used as a handle, its outer end being covered by a wet sack for collecting dust and flying chips. The collector pipe was 25 ft. long and for easy handling was balanced on a roller carried on a frame set in the mouth of the retort. The device was extremely satisfactory on the work upon which it was employed.—*Engineering News.*

MINE VENTILATION

BY CHARLES A. MITKE.*

At the Copper Queen mine, Bisbee, Arizona, the Spray, Gardner, Lowell, and Sacramento divisions are ventilated entirely by mechanical means. After the pressure and exhaust systems of ventilation were carefully studied, the former method was adopted. In this system all mine fans were placed underground on the deepest working levels of the different divisions so as to draw the air down the intake shafts, force it through the workings and stopes, and exhaust it to the surface through upcast shafts.

The reasons for adopting the pressure instead of the exhaust system are as follows:

1. More practical. Since all the deep shafts

---

*Abstract from Bulletin No. 105, American Institute of Mining Engineers.

of the Copper Queen are in operation and a large amount of work is done around each, as for example, men going on and coming off shift, handling timber, tools, and supplies, etc., it would not be practical to have an exhaust fan on the surface near the collar of the shaft. In the Gardiner, a subway below the collar of the shaft would be out of the question. Consequently a large air-tight chamber, inclosing nearly the entire head-frame, would have to be built if a suction fan were used.

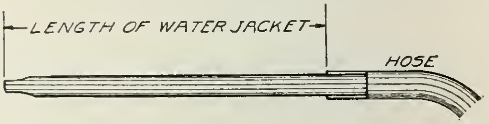
2. Better control of mine fires. The pressure system is the more advantageous in case of mine fires. With this arrangement, the entire workings are under pressure, and the gas or smoke from a mine fire may be coursed to exit through neighboring shafts that are not in operation. Since the air is under considerable pressure at the bottom and sides of the present fire districts and each of the outlets over them is provided with regulator doors, the quantity of air passing through the fire zone can be increased or diminished at will, and consequently the fire can be brought under control more readily than with the exhaust system.

3. Greater efficiency. Since the Spray, Gardner, Dallas, and Sacramento shafts are natural down-casts, the mine fans were placed underground so as to take advantage of these circumstances and multiply the volume of the natural down-case from five to ten times. The pressure system, therefore, has the advantage of the additional natural ventilation, which evidently would be lost with the other system; and more power would be required for the same quantity of air if the natural down-casts were changed to up-casts by suction fans.

4. Greater safety. Experience in the Lowell mine fire showed that in the event of the connections being closed between the fire and the suction fan, there is a possibility of smoke and gases entering the workings below and endangering the men. In the adopted system, the maximum air pressure is below the fire district, which makes it impossible for gases to go down, even if bulkheads of a sealed fire district should be opened suddenly by caving ground. At present a churn-drill hole is being put down to a depth of 1,100 ft. over the old Lowell fire stopes. When this is completed water will be run in to cool the area. No trouble is anticipated, since this was thoroughly tried at the Holbrook, where a large amount of water was turned into churn-drill holes, and no smoke or gases were taken down against the pressure of the mine fan.

ADVANTAGES OF NEW SYSTEM.

(1) A smaller quantity of compressed air is used for ventilation. (2) All possible natural ventilation is utilized, and the general direction of air currents is the same for both natural and mechanical ventilation. (3) There is a decrease in temperature, and a lower percentage of humidity and CO_2 throughout the mine, which means healthier working conditions. (4) A saving of eight 5-hp. blowers was made, as these have been removed from the mine. (5) The five lower divisions are under pressure, which partly acts as a check in preventing some mine fires from crossing the Copper Queen side-lines, as for example, the proximity of one mine fire near the Gardner workings. (6) Less decay of mine timbers. (7) The volume of air has been increased from 60 to about 300 cu. ft. of air per man per minute. (8) Formerly a large amount of moisture kept the timbers and working places in a damp condition, and fungus also covered most of the timbers. Since the mine fans were started, a large amount of water is removed daily from each division by the air currents, so that the mine is comparatively dry and the growth has disappeared. (9) The increase in velocity and volume of air resulted in the greater efficiency of the men. And (10) the new ventilating system is advantageous to the mines adjacent to the Copper Queen; there is a great deal of broken and stoped ground along side-lines, permitting a large amount of air to escape through these avenues and ventilated stopes beyond the Copper Queen boundary.



WASHING OUT COMPRESSOR WATER JACKETS

The cooling water used in the water jackets of air compressor cylinders is not always as clear as it should be, and as the circulation of the water is not rapid an excellent opportunity is afforded for the disposition of sediment and as a consequence the choking up of the passages is not infrequent. This matter is brought up in a recent letter by H. A. Jahnke in Practical Engineer. He says:

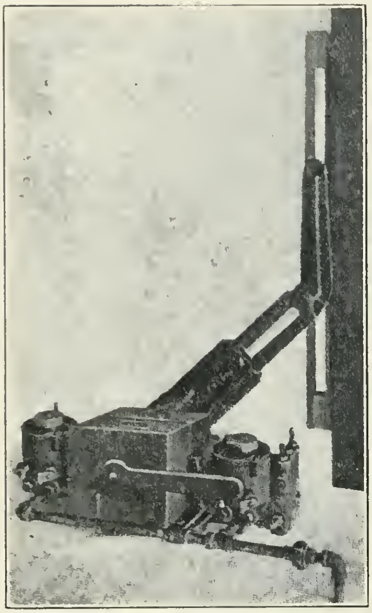
I believe the water jackets on some air compressors are not kept as clean as they should be. This is bad practice and may cause trouble some day. They should be inspected occasionally and washed out as often as found necessary instead of waiting until nearly all water space is clogged up with mud or other matter. I have found it a good idea, in washing out the water jacket to use a long nozzle made of ¼ or ½-in. pipe pointed at the end and as long as the water jacket, as shown in the illustration. In this way, the water space at the front head is much better cleaned of sediment and mud which accumulates there. With this nozzle you can play the water directly on the parts of the back head, which is not effected where a short nozzle is used. This arrangement is especially good where there is not much water pressure, as I have run water jackets which were nearly clogged up with mud, due to the fact that there was not water pressure enough to wash this out.

THE GREATEST TUNNEL IN THE WORLD

In spite of the heavy calls made upon her manhood in consequence of the war, France has not entirely given up civil engineering constructional work, and at the beginning of the month there was a formal celebration of the completion of one phase of a very important undertaking. This was the piercing of a tunnel which is to form part of a canal joining Marseilles with Arles, on the Rhone. The idea of connecting the great Mediterranean seaport with the vast systems of internal waterways which exist in France had been mooted for many years, but the present scheme was only finally adopted some twelve years ago. The length of the canal is to be 82 kiloms. (about 51 miles). The first five miles at the Marseilles end will be in the sea, though protected from it by a breakwater. The next 7266m. (say, 4.6 miles) will be entirely in a tunnel, which is being driven in a straight line under the Rove hills. On leaving the tunnel the canal will pass through a long cutting to near Marignane, from which place it will run along the southern shores of the lagoons of Bolmon and Berre as far as Martigues, where it will unite with the existing canal between that place and Porte de Bouc. That canal will be widened and deepened to meet the new requirements. From Port de Bouc to Arles it will make use of another existing canal, which will be entirely remodelled. It was the completion of the piercing of the tunnel portion which was celebrated on May 6th. The tunnel itself is driven in the solid rock, and its roof is to be lined inside to a radius of 12.503 m. At the towing path level it is 22 m. (72.18 ft.) wide, and as there is a towing path 2 m. wide on each side the width between the curbs of the towing paths is just over 59 ft. The minimum depth of water at the lowest tides is to be 3 m. (say, 9 ft. 10 in.). Its cross section rather than its length is the chief characteristic of this tunnel. In cross-sectional area it is approximately six times as large as an ordinary railway tunnel for two sets of lines. It will, when entirely completed, have necessitated the excavation of more material by far than any tunnel yet driven. The rock removed will be some 50 per cent. more than that taken from the two Simplon tunnels, and very nearly double that from the St. Gotthard. It is estimated that the canal will be in operation in another three years.—*The Engineer,* London.

"WAVE" POWER TRANSMISSION FOR ROCK DRILLS

Considerable interest has been aroused among engineers and mining men on the Rand regarding the application to rock drills of the newly-discovered method of transmitting power, known as wave transmission. A description of the principles of this novel system will not be available for publication until the formal introduction of the subject through the auspices of one of the London scientific societies. In the mean time practical developments are being pushed forward and within a few months underground trials of rock drills worked by wave transmission will be carried out on the Rand. Favourable arrangements have been made for this purpose with the Central Mining and Investment Corporation. Assuming these trials to reproduce the unique results obtained at the surface trials in London, the general adoption of the new system on the Rand should lead to an important reduction in mining costs.—*South African Mining Journal.*



DOOR OPERATING PNEUMATIC ENGINE

The halftone shows a pneumatic motor of a new type brought out by the Consolidated Car Heating Company for operating car doors. The control of the motor is electro-pneumatic by means of valves placed on each side of the engine. The air is cut off the engine at each end of the stroke. This economizes on the amount of air used as it eliminates all losses from leather leaks. At the same time it permits of atmospheric check or cushioning, which has proved to be the most reliable.

The engine has a safety feature which permits a small amount of pressure exerted by the passenger to hold up the door in case of premature closing. Further, the door may be pushed open 5 in. when fully shut to release clothing or anything that might be caught in the door. This is the limit of emergency opening, there being a positive stop to prevent a false opening. The engine is extremely light on account of its construction, the cylinders being of brass tubing. The arm, rack and pinion are made of cast steel. The engines are controlled by the standard Consolidated type push button for door control, which has been perfected for the past four years. Fifty equipments of these engines are being installed on cars of the New York Municipal Railway.

MINERS' PHTHISIS AN ANCIENT DISEASE

In a paper read by J. de Fenton, Ph.D., before a meeting of the Chemical, Metallurgical and Mining Society, it was shown that although miners' phthisis is commonly spoken of as quite a recent type of disease, it is in reality a sickness with a fairly long, if fragmentary, record. Pliny the Elder refers to respirators, and long before him Hippocrates, the Greek, spoke of the metal digger who breathed with difficulty and was of a pale, wan complexion. But it is not till we reach the days of Agricola, as Dr. de Fenton tells us, that we get what may be called a real practical diagnosis of miners' phthisis. There is no question of the identity of the disease, as Agricola studied it nearly four hundred years ago in Bohemia and as it prevails today in the mines of the Rand and elsewhere. For this reason the description of it in Agricola's famous book, "De Re Metallica," is of special interest to us. Until four years ago no translation of the work into the English tongue appears to have been made; but in the year 1912 one was published by Mr. and Mrs. Hoover. Since it became necessary to study what Agricola actually had to say with regard to miners' phthisis, a careful comparison of the translation with the original work was made, with the result, we learn that the former leaves something to be desired. It was mainly from this point of view of accuracy that Dr. de Fenton dealt with the matter in hand, and with his exceptional and wide knowledge of grammatical construction and word values in Latin it is not to be surprised at that he established a strong case against certain renderings of Mr. and Mrs. Hoover. The translators state it to be one of the three objectives in a work of this kind "to give a faithful, literal translation of the author's statements." The following extract relating to phthisis may be taken as an example of rendering into English to which Dr. de Fenton rightly takes exception. Mining is said to be a perilous occupation because, amongst other reasons, "metallorum fossores . . . haurientes pulverem pulmones exulcerantem, macie extabescant." The Hoover translation says briefly for this: "their lungs rot away," which is quite unsatisfactory from a medical no less than from a literary point of view.—*South African Mining Journal.*

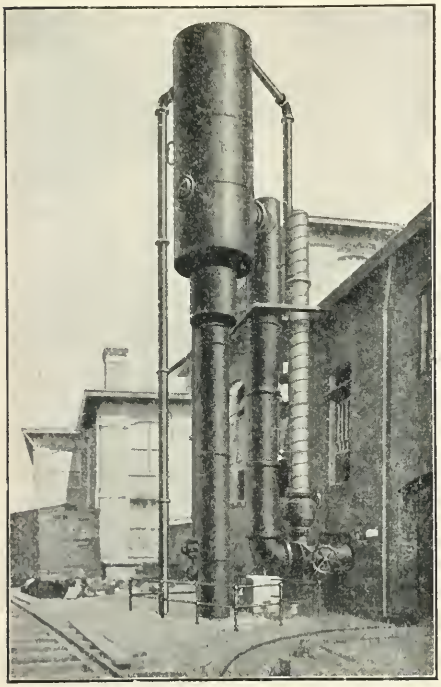


FIG 1.

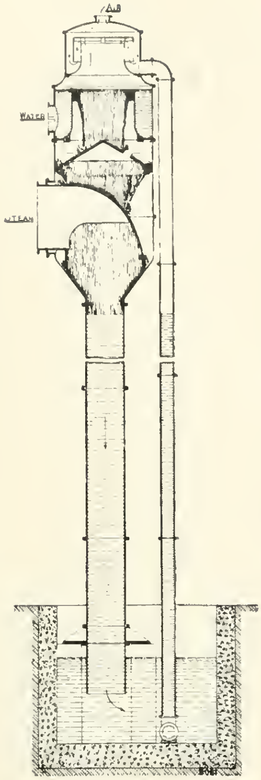


FIG. 2.

THE BEYER BAROMETRIC CONDENSER

The Ingersoll-Rand Company is now offering to the trade complete steam condensing plants for all service conditions. The equipment includes the Beyer Barometric Condenser, for which the company has secured the patent rights, Imperial duplex and Ingersoll-Rogler straight line, reciprocating, dry vacuum pumps and, where required, Cameron simplex and centrifugal pumps.

The Beyer Barometric Condenser is of the counter-current type, in which air and cooling water flow in opposite directions. The steam inlet is at the bottom of the condensing vessel, the water inlet above and the air removal opening at the top. The sheets of cooling water overflowing the pool at the inlet point meet the entering steam. The two are brought into intimate contact by conical baffle plates, thus assisting the water to absorb to its full capacity the latent heat of the steam. The non-condensable air liberated in the condensing action rises through the falling water to the removal point at the top. It is to be noted also that ample opportunity is given for the removal of the air content of the water before it mixes with the steam. This, the manufacturer points out, not only facilitates the mixing process but permits the removal of air and vapor at a comparatively low temperature, a distinct advantage as the reduction of volume saves in vacuum pumpage horse power.

The steam inlet is of large diameter to secure low velocity, and is hooded in such a way as to discharge the steam into the center of the condensing vessel. The air removal opening is also of ample area and is protected by a self-draining baffle and trap. This, it is said, positively prevents water being carried over into the vacuum pump.

The hot waste water is discharged through the self-draining tail pipe. This pipe straddles the hot well and rigidly supports the condenser.

VACUUM PUMPS

The Imperial and the Ingersoll-Rogler Vacuum Pumps are of the manufacturers' standard type. They are high-speed reciprocating machines, wholly enclosed, automatically lubricated and are said to effect a floor space saving approximating 50 per cent. over that of the more common, slower speed vacuum pumps.

When a water pump is required to elevate cooling water to the condenser head Cameron pumps are provided. These may be either reciprocating or centrifugal as desired. The Ingersoll-Rand Company, however, emphasizes the fact that, where the level of the cold well is of sufficient height above the hot well, the condenser will lift its own cooling water, dispensing entirely with a water pump.

The manufacturer in presenting this equipment brings out the point that the vacuum and water pumps, being independently operated, can be regulated to suit varying water temperatures and conditions, and that this plant, in addition to its efficiency in general service, is admirably adapted for duty as a central condensing unit serving a number of prime movers.

TWELVE YEARS PROGRESS IN ROCK DRILLING

BY H. P. GILLETTE

Some branches of civil engineering work have experienced remarkable changes during the past decade, notably road building. Other branches have changed relatively little. The art of rock excavation falls among the latter. In rewriting a book that was published 12 years ago the editor was struck by the fact that nearly every fact that he had given in the original edition is still pertinent. It is true that many additional facts are now available, but they serve, in the main, either to reinforce conclusions established 12 years ago or to give greater details under a greater variety of conditions than were then available.

The two most important innovations in rock excavation that have occurred during the last generation are the use of the cable drill for deep holes and the pneumatic hammer drill for shallow holes. But each of these types of drill had begun to be used fully thirteen years ago.

The cable drill, originally developed for well drilling, was first used for blast hole drilling in 1913 and its use was first described by the editor who was at that time on the staff of another engineering paper.

To a superintendent who had used well drills the thought occurred that the same type of drill would be economic on railroad grading. His employer, however, could see no merit in a cumbersome well drill for such purpose and would not permit him to experiment. However, when the contractor's back was turned, the superintendent rented a well drill and began using it for drilling blast holes. It was a pronounced success, but the contractor was so exasperated at having his orders disobeyed that he "fired" his inventive superintendent without waiting for excuses. But when he discovered that the well drill had not only greatly reduced the cost per foot of drill hole but had made it possible to space holes farther apart, he sent for the discharged foreman, and, according to unverified rumor, remarked: "The Bible says fools rush in where angels fear to tread, so I guess I needn't be backward in taking off my hat to a man who was a big enough fool to think of using a well driller on a railroad cut. You've struck oil on this job and your salary will be doubled."

Who the man was that thought of using a pneumatic riveter for drilling rock, history fails to mention. Probably its first use was in drilling plug and feather holes. At any rate the editor first saw the "air hammer" used in a Massachusetts granite quarry for that purpose. Subsequently this type of drill began to be used in mining, where it speedily gained popularity and coincidently grew in size.

Another innovation that dates back less than ten years is the "wagon-mounted percussive drill," which consisted of a truck (often self-propelling) carrying a percussive or piston drill mounted so that it can be raised and lowered bodily in "gins" or "leads" (similar to those of a pile driver), mounted on a turntable. Doubtless this design was suggested by the mounting of subaqueous drills in "leads" on scows. Where the rock surface is comparatively level the wagon-mounted drill is apparently destined to grow in popularity. As stated in our issue of May 24 one of these wagon-mounted drills averaged 200 ft. of hole per 10 hr. day for 2½ years on the Sag Channel of the Chicago Drainage Canal, the holes being 3½ in. diameter and about 12 ft. deep in limestone. Such a remarkable achievment would be impossible with a tripod drill because of the large percentage of time lost in shifting from hole to hole and in the more frequent changing of bits required where the entire drill machine can not be raised and lowered bodily in "leads." In Gillette's "Rock Excavation" the best long-time record of tripod drilling on the Chicago Drainage Canal was 82 ft. of hole per 10 hr. shift, holes being 12 ft. deep and 2 in. diameter at the top. This, it will be noted, is only 40 per cent as much footage (with a smaller hole) as has been averaged in the same rock with wagon-mounted drill above referred to.

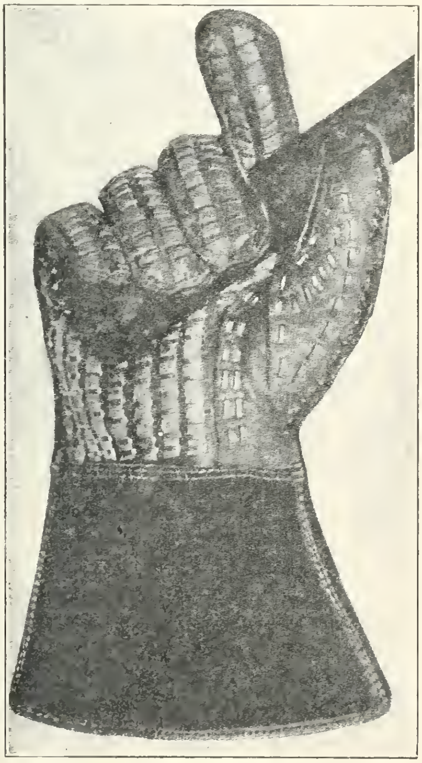
The mounting of a drill on trucks of course permits the use of a larger machine, and this, in turn, makes it possible to drill holes of greater diameter and of considerable depth. Holes 4 in. diameter at the bottom and 30 ft. or more deep can thus be drilled economically. With deep holes of large diameter the spacing of the holes can be made greater.

A water jet to keep the bottom of a drill hole clean is not a new device, but it has come more and more to be recognized as a very effective means of increasing the footage drilled in a given time. Still, there are hundreds of contractors and superintendents of rock work who have yet to learn the merit of this simple expedient, particularly as applied to rock that chips off in comparatively large fragments under the blows of the bit. The larger the chips and the bigger the hole the greater must be the volume of water forced into the hole through the jet pipe, in order to lift the chips out of the hole. If the rock chips are not removed as rapidly as they are made, the drill spends much of its time acting as a pestle pulverizing them, instead of breaking off new fragments of rock.

Percussive electric drills and gasolene drills have, as yet, not come into general use. Electricity is readily transmitted at small cost; gasoline makes each drill its own power plant. Yet the difficulties that attend the use of electricity and gasoline in rock drilling are so great that these two sources of energy have been slow of adoption for this purpose.

Rock augers have been successfully used in tunnels and other underground work where the rock was soft. It is not beyond the range of possibility that during the next ten years the auger type of drill will be extensively used in open cut work where shale and other soft rocks are encountered. In the California oil fields the auger type of well drill has grown in popularity. Those who contemplate drilling blast holes with augers will do well to study this type of drill as used in well drilling. It seems to be especially adapted for boring holes of very large diameter, and for that reason its use may prove economic even where the cost per foot of hole is high. Large holes heavily charged with explosives may be spaced far apart, and thus effect a low drilling cost per cubic yard of rock.

In general there has been a growing tendency in open cut work to drill holes of larger diameter. We believe that we have by no means reached the economic limit in large blast holes.—*Engineering and Contracting.*



SAND BLASTING GLOVE

The striking half-tone above which has such a warlike look is taken from a glove of novel type which has been developed by the Hickory Steel-Grip Glove Company, Chicago, for the use of sand blast workers. It is a rather complicated production, being made of chrome tanned horsehide reinforced with strips of napa leather which are fastened to the horsehide with small steel ribbons clinched on the inside in a layer of canton flannel. This covers the sharp edges and prevents them from scratching the hand. All the seams are stitched with fine steel wire and no cotton or linen thread is used on the wearing surface. The thumb is placed on the side seam so that the glove may be worn on either hand and the gloves may be bought either by the pair or singly. The reversible feature enables the wear of the glove to be equalized on the two sides. A heavy gauntlet protects the wrist and extra reinforcement is provided at the thumb seam.

THRILLING EXPERIENCE AND NARROW ESCAPE OF A DIVER

Seattle, Wash., July 2.—Rescued from the bottom of Elliott Bay at Smith Cove, after he had been fifty feet below the surface for five hours and forty minutes, A. Verbeck, 49, a deep sea diver, was revived and has a chance for life after being long given up for dead.

Verbeck was imprisoned at the bottom when ropes attached to his diving suit became entangled among some steel rails which he was working to enclose in a sling in order to raise them to the surface. The diver was on the floor of the bay from 7 P. M. until 12.40 A. M., when rescuers who had been working for several hours managed to bring him to the surface.

The rescue party had long before given up all hope of saving Verbeck's life. Their surprise was only equalled by their joy when they found that the supposed corpse was still breathing, and in a few seconds it was found that Verbeck was not even unconscious, never having been completely overcome during all the hours below.

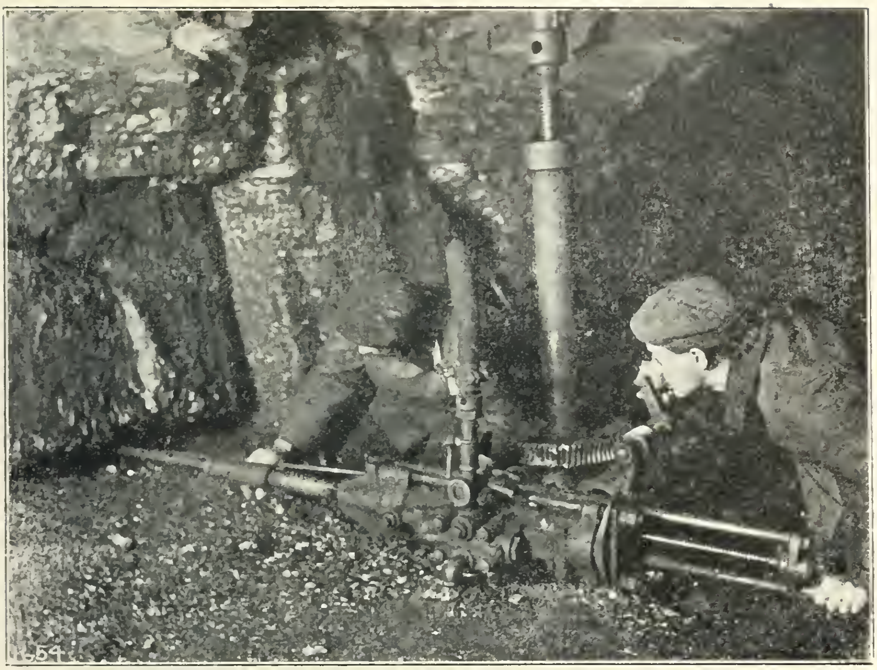
The diver is a man of powerful physique, to which is attributed his marvellous resistance. Other divers and men familiar with this sort of work said that three hours was supposed to be the maximum at which a man could live at the depth to which Verbeck descended.

Verbeck was at the bottom for about an hour and a quarter before the accident occurred. He had already fastened the lines around three rails, which were brought to the dock. Suddenly several men who had been pumping air to the diver failed to obtain any response to their signals. They at first thought there was something wrong with the signal, but later, when there appeared to be no signs of activity at the bottom of the bay, they decided to investigate.

Henry Finch, another deep sea diver, was taken to the dock in an automobile and he immediately went into the water. Within a few minutes he returned with the word that Verbeck was probably dead. Finch said that the lines fastened around Verbeck's body had evidently become entangled in the rails. The diver was imprisoned under one of the rails and he was buried deep in the sand at the bottom of the bay. A physician was called and a pulmotor and ambulance were rushed to the scene, but the rescuers were unable to release Verbeck for more than two hours.

INDUSTRIAL DESICCATION

An industry that is sure to be developed in the near future is the drying of agricultural products, such as potatoes, and also aqueous industrial residues, such as come from sugar making and from breweries. In France the process is now applied for drying fresh beets, and there are also three beet sugar works which employ it for the drying of the exhausted pulp. In the north of France there is now being worked an industrial process for making "sugar flour" from fresh beet pulp, and a desiccator is employed here in the shape of a tower into the top of which the pulp is poured, and it comes in contact with warm air; then the pulp is delivered by a rotary device on a set of superposed gratings, where it receives hot air, commencing at a lower temperature and afterward using warmer air up to a temperature of 120 deg. C. (248F.) Such dried beet pulp produces a flour which has the sweetening property of sugar to a certain extent, and could be used in all cases where the sugar is not required to be pure, such as in breweries, for special breads, for feeding stock, and the like. A ton of beets gives over 500 pounds of flour, which sells here for $2 the hundredweight. Its composition is: Albumens, 6 per cent; saccharose, 66; carbohydrates, 13; cellulose, 5; water, 6; miscellaneous, 4 per cent. Following the success of the present methods, it is thought that other industrial drying processes will be invented which will, for instance, enable stock to be fed on dried potatoes, as these are so difficult to keep in the usual state. Damp grains harvested in bad years also can be dried. Apparatus like this could use waste heat from factories.



UNDERCUTTING WITH A RADIALAXE.

COMPRESSED-AIR COAL CUTTERS IN CANADIAN MINES

BY S. W. SYMONS.

In the bituminous mines of western Canada the compressed-air column-mounted coal cutters of the Radialaxe type have made a reputation for themselves owing to their low cost of upkeep and operation. One of the largest mines using Radialaxe machines is that of the Dominion Coal Co. at Cape Breton. These cutters are for the most part being operated in what is known as the Phalen seam, which is about 6 ft. high and almost level.

The rooms average about 20 ft. wide and are undercut by the Radialaxe machines to the full depth of 5 ft. 6 in. or 6 ft., and the coal is brought down by the three-hole system. One hole, known as the plug hole, is placed about the center of the room, 4 ft. from the bottom, and another is drilled at each corner of the room about a foot from the rib and the same distance from the roof. The center, or plug, hole is shot first, and the two corner holes are shot together.

The amount of coal that the machine will cut of course varies with local conditions, depending on the hardness of the coal, the presence of sulphur balls, the condition of the roof, bottom, etc. At the Dominion Coal Co.'s mine the machines cut from five to ten rooms per shift. The coal is all cut by contract, the machine miner being paid by the ton and paying his own helper, so it is rather difficult to arrive at the maximum capacity of the machines. The machine runner makes anywhere from $8 to $15 per day clear of expenses, and with comparatively light work. If he has good luck and good air pressure, he may get ten rooms finished in five or six hours.

In a test recently conducted between an air-driven shortwall chain machine and the Radialaxe (Ingersoll-Rand No. 37 Type), the former cut 46 rooms 30 ft. wide in 16 shifts and the Radialaxe cut 84 rooms 30 ft. wide in the same time.

This company submits an interesting report on the cost of upkeep on the 300 Radialaxe machines they have had in operation during the last two years. The machines were originally purchased during the years 1911, 1912 and 1913, and represented an intial outlay of something like $50,000. They have seen continuous service ever since.

The cost of repairs was taken on three different occasions—the first time in the Lingan district only, covering the operation of 200 machines for a period of six months, the average cost per machine per month being $1.50.

The second cost was taken about a year later and covered the total number of machines that had run for the period of one year. This showed the cost of repair to be $1.35 per machine per month.

The third cost has only just been completed and covered a period of one year on the 300 machines now in operation. This showed a repair cost of $1.34 per machine per month.

The majority of these machines are four or five years old, while a few are three and some two years old.

The construction of the Radialaxe follows, in general, standard rock-drill practice, having been developed from the old-time piston drill. The drill proper is a long-stroke type, the maximum stroke being 10 in., controlled by a combination tappet and air-thrown valve which allows a variation in the length. The drill is mounted on a shell having a feed of 20 in., and the whole is mounted on a column that allows of swinging the bit radially in either a horizontal or a vertical plane. This swing mechanism is operated by worm gearing controlled by the operator and can be placed in any position on the column.

The machine is built entirely of steel so as to make it as light as possible and provide for easy handling. At 80 lb. air pressure it is capable of striking 600 blows a minute, and the air consumption is approximately 150 to 200 cu. ft. per min.—*Coal Age.*

Finely powdered aluminum forms a part of two of the most destructive explosives known, one of which, ammorial, is a mixture of five to eight parts of ammonium nitrate with one part of the aluminum powder, and is used to charge shells. It is one of the few explosives which presumably can never be used as a propellant, as its action is so sudden and the force so tremendous that no gun yet dreamed of would be able to stand it.

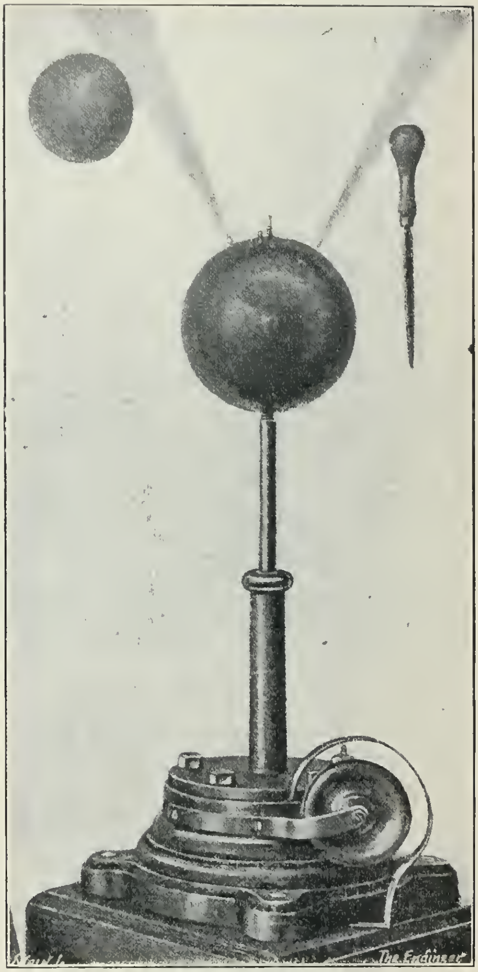


FIG 1.

THEORY OF THE BRASHER AIR BREAKWATER

The Brasher Air Breakwater, which has more than once been brought to the attention of the readers of Compressed Air Magazine, was recently described and illustrated in the pages of *The Engineer* of London, and the following letter, which requires no comment, appeared later in that publication. The matter would seem to deserve still more thought and discussion.

THE BRASHER AIR BREAKWATER.

SIR—In your issue of May 19th last, pages 414-415, you have a most interesting article on the Brasher air breakwater, and as the propagation of waves has been of some interest and study to me, I would like to suggest to Mr. Brasher that the theory on which he has originated his breakwater has a simpler basis than that offered in the article—at least, if my theory of wave action is fairly correct. The theory I put forward is based on certain experiments which I hereinafter describe, as well as on the known effects of air currents on aeronautic planes. It may possibly therefore have some general interest, and perhaps Mr. Brasher may desire to make further investigations on the lines indicated.

My theory is that a current of air of sufficient velocity, passing over a rounded surface, causes a slight increase of pressure above atmosphere on the windward side, and a reduction of pressure below atmosphere on the leeward side. As an illustration of this theory, I send a photograph, Fig. 1, of an apparatus, by which it has been demonstrated that a ball or an ordinary 8-in. file can be supported in the air if a jet of air of sufficient velocity is passed over the rounded surface of the ball or the rounded end of the handle of the file. It would appear that the velocity of the jet passing over the rounded surface increases the pressure of the atmosphere slightly on the rounded surface towards the jet, and reduces the pressure on the opposite side below that of the atmosphere, so that the file or ball is held up to the jet by the pressure of the atmosphere. That the support afforded by these air jets is of some magnitude is proved by revolving the ball of the apparatus, which, being fed from the source of the air supply through the stem, forms a small reservoir for the jets or nozzles inserted in the ball. When the ball is revolved, which is done by the small air-driven wheel at the bottom of the stand, the articles supported in the air revolve with the jets, and a considerable pull on the end of the file is necessary to detach it from its support on the jet. To obtain the support of the jet the rounded surface of the ball or handle of the file must be approached gently to the lower surface of the jet, and must not enter the jet itself. The above explanation is given in order to illustrate my theory of the action of the wind on the surface of the water shown on the accompanying diagram, Fig. 2, which explains itself. This diagram suggests that waves have a difference of atmospheric pressure on their two sides caused by the velocity of the wind over their rounded crests.

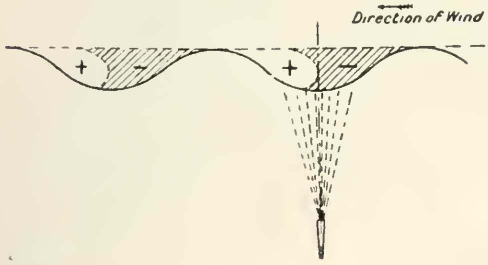


FIG. 2.

By Mr. Brasher's breakwater this difference of atmospheric pressure caused in the troughs between the waves by the velocity of the wind passing over their crests is neutralized by the admission of air above atmospheric pressure, which is delivered into that space by the jets of the breakwater from below the surface of the water and below the current of air passing over the crests of the waves. In this way the rise and advance of the waves is mechanically checked.

M. INST, C. E.

May 31st.

ADVANTAGE OF SANDBLASTING FORGINGS

BY W. C. LYTLE.

The question of removing the scale has demanded the attention of manufacturers for years and many methods such as pickling, tumbling, buffing, polishing and electrolytic cleaning, have been tried with more or less uniformly *unsatisfactory* results.

Probably the most common of methods is pickling. Forgings are pickled in a solution of sulphuric acid and water to remove the oxide scale which forms during cooling.

After forgings are removed from the pickling tank it is necessary to wash them in a hot solution of potash or soda to neutralize the acid remaining on forgings; they, also, must be thoroughly washed in hot water, which must be frequently renewed or it will become impregnated with the acid.

Often, due to careless washing or to rushing the work through too quickly, forgings are not washed free from all acid. If these forgings are immediately put through any machining operation the acid remaining on the forgings very quickly destroys the edge of the cutting tool, and a lot of time is unavoidably wasted in resharpening. If forgings are not used immediately, they rust very quickly due to the acid. The vapor given off by a pickle solution is very injurious to the machinery or anything metallic, rusting everything it reaches. Operators suffer from acid fumes and very frequently from acid burns. Forgings that have been sand blast cleaned do not injure tools or the hands of men that handle them, and if put in bins do not rust nearly so quickly as pickled forgings, nor is the rust so deep.

The advent of sand blasting heralded a new era in the manufacture of drop forgings. First we find it done by hand, developing in a short time to an art which has reduced the once very difficult problem of removing scale to a very simple operation.

The mechanical cleaning of scale from the forgings with modern sand blast equipment, barrels and tables, does away with all slop, fumes and bother of the pickling department.

In these days of "Safety First" when provision for the safety and comfort of the employe has proven a paying investment, the advantages of the sand blast as compared with the pickling vat are at once apparent. The former is as comfortable to operate as any other machine in the shop and absolutely no menace to other equipment.

The first type in general use was the hose sand blast, and where there are varied classes of work with not enough of any one class to warrant the expense of special equipment to handle same, the hose and blast is still a general favorite because of its flexibility.

In the Packard plant, Detroit, Mich., two types of these sand blast machines are in use, the barrel and table type. The table type consists of a circular grated disc of any desired size revolving horizontal with the work resting on it. By means of compressed air (preferably at 80 lbs. pressure or more) abrasive is discharged through one or more nozzles upon the work resting on the disc. By this arrangement the work is blasted on the upper side, which when completed is turned down to allow the work to be blasted on the opposite side. A bona fide example of the capacity of this type of sand blast is 60 crank shafts and 200 connecting rods in one hour. Discounting this 10 per cent. for continuous operation would show a daily (10 hours) capacity of 540 crank shafts and 1,800 connecting rods. The barrel type is equally as efficient as the table type, but its scope of work is different in that it is adapted more for small or medium sized parts of more or less irregular design. In construction it consists of a revolving barrel inside of which are placed nozzles at different angles so as to distribute the blast very uniformly and also to blast all sides at the same time. The nozzles are all adjustable to any angle with relation to position occupied by the work in the revolving drum.

The cabinet type is limited to small forgings of a size convenient to handle, and is especially adapted to plants where large capacity is not required, or where the work is delicate and must be handled carefully.

With all types, satisfactory ventilation and arresting of the dust, is accomplished by means of exhausters of suitable design, and centrifugal or screen type dust arresters. The former type of arresters are adaptable to plants where it is the desire to prevent diffusion of dust in the room where the equipment is located, and where it would not be objectionable to discharge a small amount—not more than 5 per cent. into the atmosphere. With the latter type, the dust is entirely suppressed and the purified air returned to the room from which it was drawn, instead of discharging into the atmosphere. This is a decided advantage and economy in winter, as the necessity of continually warming incoming cold air is avoided.

That oldest scientific bureau of the U. S. government—the Coast and Geodetic Survey—celebrated on April 5 and 6 the one hundredth anniversary of the beginning of its work of surveying and charting our shores. This bureau was established by that most talented and versatile of American statesmen, Thomas Jefferson, who was great not only as a statesman and a patriot, but as a philosopher, a scientist, a musician, a linguist, a diplomatist, an educator and an architect. A noted Swiss scientist, F. R. Hassler, was the bureau's first superintendent.

Although St. Paul, Minn., is surrounded by spring-fed lakes and has the finest natural ice in the world, an artificial ice plant turning out 30,000 tons per year has been found to be a paying enterprise during the first twelve months of its operation by the Citizens Fuel and Ice Co.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE

Compressed Air Magazine Company
Easton, Pa.

New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. AUGUST, 1916. No. 8

CONTENTS

Pneumatic Grain Conveyors 8067
Welding Joints in Gas Mains 8069
Engineering Explosives 8072
Industrial Preparedness 8073
Artificial Ice in Canada 8074
Air Lifts at a Cyanide Plant 8075
Dangerous Mine Gases 8076
Air Siphon for Cleaning Gas Retorts 8077
Mine Ventilation 8077
Washing out Water Jackets 8078
Greatest Tunnel in the World 8079
"Wave" Power for Drills 8079
Door Operating Pneumatic Engine 8080
Miners' Phthisis 8080
Beyer Barometric Condenser 8081
Twelve Years Progress in Rock Drilling. 8082
Sand Blasting Glove 8083
Narrow Escape of a Diver 8084
Coal Cutters in Canadian Mines.......... 8085
Theory of the Brasher Breakwater 8086
Sand Blasting Forgings 8087
Subaqueous Tunnel Record 8089
Dover Strait Tunnel 8090
Gold in Sulphur Mining 8091
Notes 8092
Patents 8095

THE SUBAQUEOUS TUNNEL RECORD

On page 8056 of our July issue a small item called attention to the record made in driving the Dorchester Rapid Transit tunnels under Fort Point Channel, Boston, the greatest monthly advance being 375 ft. The data of the work was given in greater detail in *Engineering News*, and the record claim is challenged in the following letter to that publication. It will be seen, as the writer of the letter says, that the records are not at all comparable on account of the great difference in materials and methods. The suggestion of comparison on the basis of material removed "or displaced" seems to offer no satisfactory conclusion any more than before. The letter referred to is as follows:

Sir—Referring to the article in your issue of June 1, entitled "Subaqueous Tunnel Record," in which it is stated that claims have been made that the progress in driving the Dorchester Rapid Transit tunnels under the Fort Point Channel, Boston, Mass., established a record for subaqueous tunnel driving, I beg to call your attention to the following records of progress made in constructing the tunnels under the North River for the Pennsylvania R. R. and Hudson & Manhattan R. R.; Charles M. Jacobs, of this firm, being chief engineer for both projects.

The best progress made on the North River tunnels of the Pennsylvania R. R. was in the month of June, 1906, when the North tunnel, driving from Manhattan, made 545.2 feet.

On the Hudson & Manhattan tunnels, the best progress was as follows: North tunnel, Downtown System—the progress for 3 mo., from Apr. 30, 1906, to July 31, 1906, was 2,321.5 ft. The best progress for a month was in this tunnel, in July, 1906, when 667.5 ft. was made.

The best progress for a week was in the South tunnel, from Aug. 8 to 15, 1906, when 308 ft. was constructed. The best progress for one day was on Aug. 1, 1906, when 36 rings, two feet long, were erected, making 72 ft. of tunnel for the day.

Conditions are so different in various localities that no camparison that means anything can be made. In the case of tunneling in the Hudson River silt in the vicinity of

New York, the tunnels were advanced by forcing the shield through the silt without any excavating in advance of the diaphragm, and by only admitting through the shield doors a small portion of the material displaced by the shield.

Perhaps a fairer comparison of work accomplished would be had on the basis of volume of material removed or displaced in constructing a tunnel in a given time.

JACOBS & DAVIES, INC.,
George D. Snyder, Director.

30 Church St., New York City, June 6, 1916.

THE DOVER STRAIT TUNNEL

The great world-war in which by the irony of fate our most civilized nations are engaged stirs thought and discussion anew as to the desirability of the long planned channel tunnel to connect England and France. If such a tunnel had been completed and in service before the war began it apparently would have been of great service to the allies, and, as it has turned out thus far, there would have been no difficulty, we may believe, in guarding it and maintaining it in constant operation, although it must not be lost sight of that a charge or two of high explosives placed by experts could very quickly put it out of use and perhaps flood it so that it could not be brought into service again for years, if ever, and there are daredevils enough who would quickly risk their lives upon such a scheme. If there were an insurance company big enough to insure the tunnel against the war risk it would be interesting to know what the rate would be.

Professor Alglave of the law faculty of the Corbonne has been giving out some speculative computations as to the tunnel possibilities. It could have been built, it is said, for the cost to England and France of four days of the war, say 400,000,000 francs. To have symmetrical figures let us say $100,000,000. It would have permitted the transportation of 122 trains of troops in a day from England to France, and 60,000 tons of freight per day. Prof. Algrave contends that the enterprise if begun at the outbreak of the war could have been carried to completion before the end of the conflict, which is assuming either rapid tunneling or wofully prolonged fighting. Since comparatively few men would be required or could be employed on the work why not begin on it at once? While there were many in doubt as to the outcome of our Civil War the dome of the capitol was carried to completion.

SERIOUS ACCIDENT IN DRIVING A BOSTON TUNNEL

What is known as the L Street, South Boston, bridge tunnel which is being driven by the pneumatic process was the scene of a disastrous and fatal blowout on June 24. The tunnel is being built as an electric cable conduit under the Reserved Channel from two shafts 984 ft. apart. It is a 7 ft. circular tube 70 ft. below the water surface. Preliminary borings had shown the usual harbor silt, coarse sand and gravel, silt and sand, stiff blue clay and finally a hard stratum of sand, gravel and clay through which the tunnel was being driven. The shaft was sunk to a depth of 80 ft. as a steel caisson, using compressed air and reaching a maximum air pressure of 30 lb. Excavation for the horizontal tunnel had been carried but a short distance when the accident occurred. Four men had just entered the heading and they were carried out by the blowout, their bodies not having been recovered, and the inrushing water nearly filled the shaft. The tunnel walls are 12 in. thick and the shaft walls 16 in. thick. Accounts are not clear, but there seems to have been a general collapse of the shaft with displacement of the air lock rather than merely a blowout at the heading.

TECHNOLOGY OF MARBLE QUARRYING

The above is the title of a bulletin just issued by the Bureau of Mines of the Department of the Interior, Oliver Bowles, quarry technologist, being the author.

The aim of this bulletin is to present to the marble workers of the United States a concise statement of the most efficient and economical methods now in use for producing and preparing marble. The bulletin refers chiefly to the methods employed in the quarrying of marble and the conditions that affect successful operation; the structure of marble and its relation to quarry processes; waste through rock imperfections and inefficient quarry methods; and means of eliminating such waste or utilizing it if elimination is impossible.

"Perhaps the most important feature of the bulletin," said Van. H. Manning, Director of the Bureau of Mines, "is the pointing out of a method for relieving earth pressure in certain quarries particularly subjected to natural strains. During the process of quarrying, this strain is relieved locally and the expanding rock breaks up into irregular masses, the fractures often being accompanied by loud reports. A method of avoiding excessive waste due to the production of these irregular fragments is described. It is advised that rows of deep, closely spaced, vertical drill holes be projected in a line across the quarry in such a manner that the rock may expand and partially close the drill holes, thus giving relief from strain without the destructive fracturing. One Tennessee marble company has already tried this method and has thereby greatly reduced the proportion of waste marble, and thus effected a saving of several thousand dollars. It is believed that several valuable quarries which have during recent years been abandoned on account of excessive strain breaks could be reopened and worked profitably if the methods proposed in this bulletin were adopted."

Copies of this publication may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

A NEW OXYGEN AND NITROGEN COMPANY

The Air Reduction Company, 50 Broad street, New York, recently incorporated with a capital stock of $2,500,000, has acquired the American rights to the Claude process for making liquid air for separating the oxygen and nitrogen of the air. The company has purchased control of the Superior Oxygen Company, which is the second largest producer in the country, and will operate the plants of the Superior Company. Six new plants to use the Claude process will be finished and in operation in five months and inside of a year the company expects to have plants all over the country. When all of these new plants are completed the new company will be the largest producer of oxygen in the world.

It is stated that the company will concentrate its efforts first on oxygen, which is a big field, especially in oxy-acetylene use. The company has engineers in Europe investigating the calcium carbide situation with a view to manufacturing this commodity, probably in Europe, for making acetylene for use in the oxy-acetylene burner for welding and cutting. The company may also make compressed acetylene, if they take up the carbide manufacture.

Another important field which the company will enter, after having the oxygen business thoroughly organized, is the production of nitrogen, cyanamid, ammonia nitrates and nitric acid. Two or three processes for making nitric acid are being tried out at the present time and the experiments are well under way. The South is a big field for fertilizer and the company expects to establish nitrate manufacture in the South either by one central plant or several distributed plants.

THE GOLD IN SULPHUR MINING

To-day, and for 20 years past in the history of the Union Sulphur Co., we have a tale of riches that vies with the wonder-workings of Aladdin's mythical lamp. Organized in 1894 with a capital of $400,000, but $200,000 issued, it has been paying dividends claimed to be no less than 100 per cent. a month or $2,400,000 a year. The stock is held by the second generation of four families—Frasch, Twombly, Hewitt and Severance.

The story of the company's undertakings credits Herman Frasch, a German immigrant at 16, who later developed a method of purifying paraffin wax and desulphurizing petroleum, with organizing a syndicate to exploit the supposedly unworkable sulphur deposits in Louisiana. Measurements showed the deposit was a hill nearly circular, half a mile in diameter, at least 1,100 ft. deep, and covered by 500 ft. of quicksand. Frasch drove down a 10-in. pipe through which was poured water at 335 degrees, which temperature corresponds to a steam pressure of about 100 lb., gage, liquefying the sulphur, which then was pumped up.

A battery of 15 to 20 boilers heats water for each well, more than 1,000,000 barrels of oil a year being burned. A well produces 400 to 500 tons a day for months, one well yielding 73,000 tons, worth $22 a ton. Two or three great wells were brought in in 1914.

The sulphur is poured into wooden bins 350 ft. long, 250 wide and 60 ft. high. Explosives are used to break up the sulphur after solidifying. The United States output in 1880 was 536 tons, worth $39 a ton. In

1914 it was 328,000 tons, practically all by Union Sulphur Co.

The sulphur is practically pure, and needs no refining and little labor. Cost for labor, fuel, etc., is about $2,160,000 a year, and revenue, even at $18 a ton, must be about $5,760,000, leaving net of $3,600,000 on $200,000 capitalization.—*Min. & Eng. World.*

A NOVEL DRILL TEMPERING PROCESS

In a series of comparative tests of piston-drill bits made at the School of Mines, University of Missouri, the following method was tried for tempering drill bits, and it was stated that better results were secured than with any other method:

The graphite crucible containing a small quantity of salt (NaCl) was placed on the forge and the salt melted. The melting point is about 800 deg. C., (1472 F.) which is slightly above the critical temperature of the drill steel used. The steel to be tempered was placed on end in the crucible, the molten salt covering the bit to a depth of about 1½ in. The steel was left in the salt until, on removing, the salt no longer clung to it; in other words, until the steel had reached the temperature at which salt melts. The salt itself got considerably hotter than its melting point, but by watching the steel carefully, it was possible to remove it almost immediately after it had attained the proper temperature. The steel was plunged directly into a bucket of freshly drawn water. The temper obtained in this manner was believed to be as nearly uniform as it would be possible to get with any method without the use of much more elaborate apparatus. The bits were hard and tough and stood up remarkably well. It was not uncommon to drill from 12 to 15 ft. in hard granite with one piece of steel which certainly indicated a good temper for the bit.

SHOP SIGNALS

Mr. H. V. Haight, Chief Engineer Canadian Ingersoll-Rand Company, Sherbrooke, Canada, writes as follows in *American Machinist*:

In our shop we tried both automobile horns and an 8-in. electric gong, but did not find that either of them could be heard very well more than 100 ft. away. We got a good suggestion from the Canadian Pacific Ry. shops in Montreal, to the effect that they were using locomotive whistles with electrically operated valves controlled from the timekeeper's office. It was stated that these whistles could be heard distinctly all over the shop, which is over 1,200 ft. long. We found, however, that the electrically controlled valves were an expensive proposition and as an experiment put in a 1-in. pipe line direct from the power house with a 2½-in. short bell whistle at the end of it. There is a quick-opening valve in the power house. The whistle can be heard very plainly all over the shop, which is 200x325 ft. The whole equipment is very simple and satisfactory.

I have a theory that both the gong and the automobile horn make a noise so much like the ordinary noise of the machine shop that they cannot be readily distinguished. A similar experience with an alarm for a thread miller confirms this belief. The alarm was used to give warning before the spindle reached the end of the travel, to prevent a smash. I arranged a small, mechanically operated gong that made a great noise in the store where I bought it; but after it was installed in the shop, it could hardly be heard 10 ft. away. I think I will try a little compressed-air whistle on the next machine.

NOTES

The Excavation for the Rogers Pass Tunnel was finished on July 6. In the past year more than 3½ miles has been excavated—working from two headings. This double-track tunnel is being built for the Canadian Pacific Ry., by Foley Bros., Welch and Stewart. A. C. Dennis is superintendent for the contractor.

Dispatches from Rome announce that a violent earthquake on July 6 caused the loss of many lives, variously estimated at from 100 to 300, in the sulphur mines of the district of Caltanissetta, Sicily. It is stated that the victims were in three sulphur mines, which the earthquake caused to cave in. This is the only instance, which we can recall, of an important mine disaster resulting from an earthquake.

Out in California a centrifugal blower, driven by an electric motor, is being used in the shelling of almonds. Formerly the nuts could be shelled by hand only with the greatest difficulty. At the present time the almonds are fed into the suction side of the fan, where they are picked up by the runner and hurled against the fan casing, following which they are blown out of the discharge pipe into a box, already shelled.

One thousand and thirty-six U. S. patents were issued under the weekly date of July 4.

The United States has 68 ports each doing an annual business of more than 1,000,000 tons or a valuation of $30,000,000.

Five tons of newspapers and seven and a half tons of dirt are cleaned off the steps and platforms of the New York subway station every twenty-four hours.

It is estimated that something like 300,000 men have left the coal mines of Great Britain to either join the army as soldiers or to enlist in the special entrenching and tunneling corps.

Five hundred and two feet of advance in one month was made last January in the Tiger adit (8 by 9 ft.) of the Burma Mines Corporation by Chinese miners, under white shift-bosses, using three Leyner-Ingersoll drills at the face and mule traction up to a length of 6,000 ft. The rock is rhyolite.

Baking powder, sugar, artificial silk, silk stockings, twine, furniture, milk bottles, rugs and "the strongest paper ever made" are some of the things which the National Lumber Manufacturers' Association of Chicago reports as being successfully produced at Madison, Wis., in the forest products laboratory of the United States Department of Agriculture.

Last year there were almost 2,500,000 motor cars registered in America, or one for every 44 persons. Iowa led with one for every 16 persons. The number of motor cars in 1915 was almost double the number in 1913. Motor car owners paid more than $18,000,000 in taxes in 1915, most of which went into road improvement.

The following we clip from a daily newspaper of recent date and it may be news: "A company has been formed at Boston to manufacture liquid air for automobiles and as the driving power for all kinds of machinery. By the use of liquid air the company claims that an automobile can make a trip of 100 miles at a very small expense."

Frank Gartland, of the Pueblo, (Colo.) Gas & Fuel Co., has gained quite a reputation as a specialist in the cure of hay fever in adults and whooping cough in children. He has successfully treated about 15 children and a half dozen grown persons. The Gartland whooping cough treatment consists in having the children inhale fumes from the scrubbers, while for hay fever the patients inhale the fumes from the ammonia machine.

Joseph Taylor, a coal operator of Belleville, Ill., has submitted to the Commercial club a proposition for tunnelling under that town by removing the coal strata for the purpose of diverting part of the flow of the Richland creek and preventing floods. Mr. Taylor is willing to assume the work of driving the tunnel through for the sake of the coal which would be removed.

Blowing cotton from one department to another through suitable tubes is the latest employment of compressed air in manufacturing plants. In one instance a California felt manufacturer makes use of compressed air for conveying damp wool from the scouring plant squeezers to another building across the street, in which are located the sun-exposed drying rooms. The method is of course clean and rapid.

A drilling contest between a single-jacker and a jack-hamer arranged by Louis A. Rehfuss, West Point, Calaveras County, Calif., resulted in the jackhamer, with air at 60 lb., drilling 81 in., while the hammersman drilled 9 in. The cost per jackhamer shift figured out 1.75 times that of the hand-drilling shift, but the cost per foot of hole drilled by the jackhamer figured only 19½ per cent. of the cost of hand-drilled hole.

The old steam calliope of the circus parade is being superseded by an air operated apparatus which is superior in many ways. Where the steam calliope had 32 pipes the new instrument has 43, or even 55 whistles, ranging in diameter from ½ in. to 5 in. and up to 4½ ft. in length. Pressures used range from ¾ to 20 lb., and the blower or compressor is driven by a gasoline motor, or, when stationary, by electricity.

A disastrous dust explosion in No. 3 grain elevator of the Pennsylvania R. R. at the Canton terminal at Baltimore, Md., destroyed the structure and the 1,000,000 bu. of grain it contained, and set fire to a 700-ft. pier and two steamships. Five were killed and the property loss amounted to $2,000,000.

In denying the right of a mine driver to recover for injuries sustained when he was kicked by a mule which he was driving, on striking the animal with a whip, the Kentucky Court of Appeals said: "The mule would have been untrue to itself and to every tradition of its breed if it had kept its heels on the ground and an employee cannot court danger by inviting a mule to kick him and then recover for consequent injuries."

Baltimore was the first city in the United States to establish public gas lighting. The Gas Light Co. of Baltimore on June 17, 1816, received a franchise from the City Council to lay pipes for distributing gas. This was only four years after the introduction of gas light in London by the Gas Light and Coke Co., the first gas undertaking in the world. Boston introduced gas lighting in 1821 and New York City in 1823.

An electrically-operated cleaner for blackboard erasers has lately been introduced by an American manufacturer. It consists essentially of a vacuum fan operated by a 1/25th horse-power electric motor. Not only is the chalk dust removed by the strong suction of the fan, but the surface of the eraser is cleaned by a rotating bristle brush. The chalk is drawn into a box, from which the air escapes through a fine muslin filter. It is claimed that no chalk escapes into the room.

Dr. Robert Gans, of Pankow, near Berlin, Germany, has been awarded the Elliott Cresson gold medal by the Franklin Institute for his discovery and development of "Permutit." Permutit is sodium-alumino-silicate used for softening water, having the remarkable property of exchanging its sodium for the hardening ingredients—calcium and magnesium—in water filtered through it. When the "Permutit" has been exhausted of its sodium, it may be regenerated with a solution of common salt.

Elephant Butte dam in the capacity of its reservoir ranks every other storage dam in the world completely controlled by man. Its reservoir when full will contain 856,000,000,000 gal., or enough to cover the State of Delaware 2 ft. deep. This is a third more than is stored by the $17,000,000 Assuan dam in Egypt and two-thirds more than the combined capacity of all the reservoirs built or projected for Greater New York City. On top Elephant Butte is 1,674 ft. long; it contains 610,000 cu. yd. of rubble concrete and weighs a million tons.

The remarkable growth of the aeroplane industry of the United States is indicated by the exports of 398 aeroplanes for 1915 against 40 in 1914 and 19 in 1913. The value of the 1915 exports was $2,960,814 or an average of $7,439 per machine, against $6,337 in 1914 and $3,227 in 1913. The exports of aeroplane parts were also very large, amounting to $2,457,782 as compared with only $145,997 in 1914 and $25,606 in 1913. Imports of aeroplanes into the United States decreased from 16 and 13 in the fiscal years of 1912 and 1913, respectively, to only 1 each in the fiscal years of 1914 and 1915.

There has been a superstition about accidents that they were something inevitable, the outcome of fate. When the pious workman lost his leg, it was God's will. If he was not a religious man he said the accident "was coming to him," and the man beside him said, "I am going to get mine some day." That was the way workmen talked in general 15 to 20 years ago. And the man at the factory or railroad had the same attitude: "Accidents are unavoidable. It's one of the prices we pay for progress." Blood and shattered bodies, that is the price we were paying for prosperity, and the public at one time agreed that the cost could not be avoided.—Ida M. Tarbell.

Protection of a large gasolene tank at Balboa, on the Panama Canal, against accidental ignition of its contents is being carried out on the Martini-Hueneke system. The principle of the system is the maintenance of a blanket of incombustible gas in the storage tank above the surface of the gasoline. The plant consists of a gasoline engine driving a gas compressor, gas scrubbers, and an inert-gas storage tank. The inert gas used is the exhaust from the gasoline engine, which is cooled, scrubbed and compressed into a high-pressure storage tank. As fast as gasoline is drawn out of the storage tank the inert gas is automatically supplied to the space above the gasoline, so that no air is drawn in.

Compressed air, the air which is compressed in front of a projectile in flight, is an important factor to be reckoned with in the designing of anti-air craft guns, and in the study of their action and efficiencies. A single instance of the complications encountered is seen in the study of falling bodies. Gravity of course, if not interfered with, produces a constantly accelerated drop, but this is opposed and may be entirely negatived by the gradually increasing resistance of the air. When this resistance equals the force of gravity, no matter what the height may be, there can be no more acceleration, and in fact, on account of the increasing density of the air there must be some actual retardation.

A new use for electric air heaters has been found by the St. Marks Hospital of Salt Lake City, Utah. Heretofore a set of four dumbwaiters running from the basement to the first second and third floors has been used for carrying food from the kitchen to the various wards. Great difficulty was encountered in keeping the food warm from the time it left the kitchen until it arrived at its destination. Now the hospital is using seven portable wagons designed by Mr. Chadron, general manager of the hospital. These wagons accommodate 26 trays and are arranged with sliding doors that make them practically air-tight. An electric air heater is mounted on the bottom of the wagon, with a cord and plug attachment capable of being connected 10 feet away from the wagon. An hour before each meal the various heaters are connected to a source of electric current in order to heat the interior of the wagons. After the wagons are loaded, they are placed on an elevator and raised to the various wards. If the meals are not to be taken immediately, the wagons are again connected to any source of electric current.—*Scientific American.*

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents Washington, D. C.

JUNE 6.

1,185,621. POWER - GENERATOR. GEORGE BOLTZ, Amy, Kans.

1. In a power generating apparatus, the combination with an air tank, an oil reservoir, and a combustion chamber, of a water jacket encircling the said chamber and having a steam drum on the upper side thereof, a valved pipe connecting said air chamber and said oil reservoir, a valved pipe extending into said oil reservoir and into the combustion chamber, the said pipe being bent back upon itself within the said chamber and open at its inner end, a valved pipe connecting the steam drum and the combustion chamber, a valved pipe connecting the air chamber and steam drum, a valved pipe extending into the combustion chamber and into the air chamber, a pipe extending into the combustion chamber and having communication with the water jacket whereby water may be sprayed into the said combustion chamber.

1,185,638. MILKING APPARUTUS. REUBEN B. DISBROW, St. Paul, Minn.

1,185,660. PNEUMATIC TIRE AND INFLATION MEANS THEREFOR. REBECCA HARRIS and NATHAN HARRIS, Newark, N. J.

1,185,684. VALVE FOR PNEUMATIC PILLOWS AND OTHER ARTICLES. HENRY P. KRAFT, New York, N. Y., and MAXIMILIAN CHARLES SCHWEINERT, West Hoboken, N. J.

1,185,708. PNEUMATIC FOR SELF-PLAYING MUSICAL INSTRUMENTS. GEORGE H. PARSONS, Stamford, Conn.

1,185,737. FLUID-OPERATED BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,185,809. SUPPORT FOR COAL AND ROCK DRILLS. NILS D. LEVIN, Columbus, Ohio.

1,185,899. HOT-AIR DRIER. CHARLES E. GEIGER, Louisville, Ky.

1,185,942. AIR-COMPRESSOR. MICHAEL RIESNER, Cincinnati, Ohio.

1,185,955. FLUID MOTOR OR PUMP. AUGUST SUNDH, Hastings-upon-Hudson, N. Y.

1,186,079. VACUUM-CLEANER. ROBERT L. COOLEY, Milwaukee, Wis.

1,186,120. TOY GUN. GEORGE MULLER, Newark, N. J.

1,186,201. DEVICE FOR SUPPLYING STEAM AND AIR TO FURNACES. GEORGE R. JARMAN, Baltimore, Md.

1,186,208. VACUUM-CLEANER. EUGENE M. KENT, Rome, N. Y., and BERT M. KENT, Washington, D. C.

1,186,247. GOVERNOR-VALVE FOR AIR-COMPRESSORS. WILLIAM EVERETT, VER PLANCK, Erie, Pa.

1,186,367. FIXATION OF NITROGEN. EDGAR ARTHUR ASHCROFT, London, England.

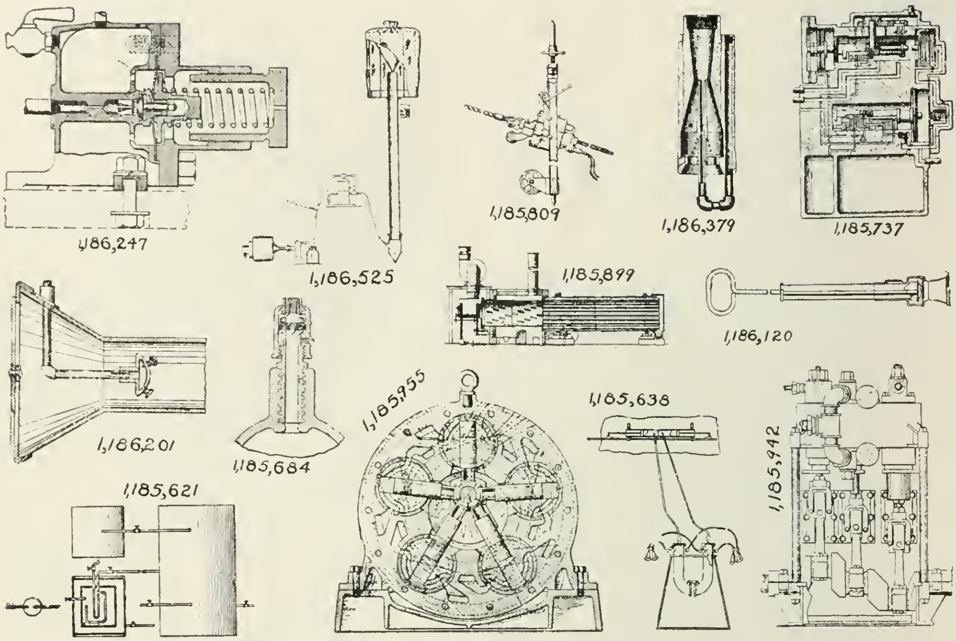
2. The fixation of nitrogen by reacting nitrogen, carbon and a metal under a pressure of at least fifty atmospheres and at a temperature of 300 degrees centigrade and upward.

1,186,369. PNEUMATIC WELL FOR INK AND MUCILAGE. BRONSON BARLOW, Chicago, Ill.

1,186,379. AIR-JET LIFT. THOMAS J. CRUMPTON, Coalinga, Cal.

1,186,525. PROCESS AND APPARATUS FOR SEPARATING AND ANALYZING GRANULAR MATERIAL. JOSEPH C. PEARSON, Chevy Chase, Md.

1. The process of separating granular material consisting in subjecting a confined body of such material to mechanical agitation and a downwardly directed fluid current regulated to maintain the whole mass in movement, deflecting and expanding the current with its suspended contents and causing the same to travel upwardly with uniform flow, and separately collecting the portions separated.

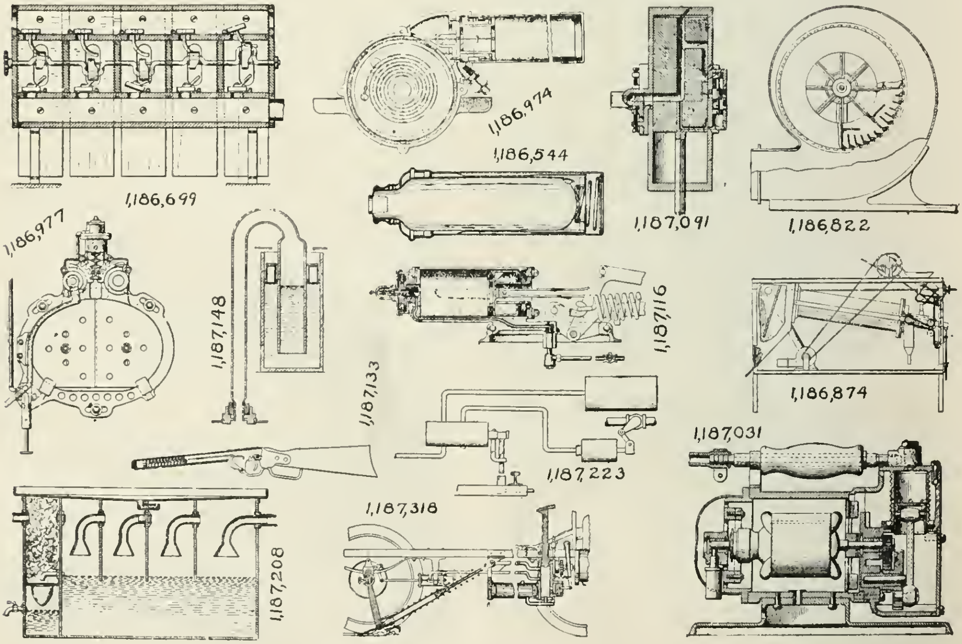


Pneumatic Patents June 6.

14,146. (REISSUE). METHOD FOR PURIFYING AND HUMIDIFYING AIR. William G. R. Braemer, Camden, N. J.

JUNE 13.

1,186,544-5. VACUUM-BOTTLE. Frederick E. Carlson, New Britain, Conn.



Pneumatic Patents June 13.

1,186,558. VACUUM CASTING APPARATUS. James E. Dunn, Pittsburgh, Pa.

1,186,572. VACUUM INSULATION. F. Walter, Guibert, Detroit, Mich.

1,186,699. PNEUMATIC MOTOR. David C. Spence, San Maeo, Cal.

1,186,822. BLOWER. Christian Neumann, St. Louis, Mo.

1,186,826. FAN - BLOWER. James Robert Peifer, Sheppton, Pa.

1,186,874. VACUUM ORE - SEPARATOR. Harry H. Baer, Orrville, Ohio.

1,186,974. PNEUMATIC STARTER FOR INTERNAL-COMBUSTION ENGINES. John Desmond, Wilmette. Ill.

1,186,977-8. FIRE-DOOR APPARATUS. Albert G. Elvin, Somerville, N. J.

1,186,981. FLUID-OPERATED TOOL. Louis W. Greve, Cleveland, Ohio.

1,187,031. AIR-COMPRESSOR. Samuel D. Black, Baltimore, and Alonzo G. Decker, Orangeville, Md.

1,187,091. FLUID-PRESSURE ENGINE. John Cooper Porter, Northampton, Mass.

1,187,116-7. TROLLEY-RETRIEVER VALVE. Frank A. Wasson, Milwaukee, Wis.

1,187,133. AIR-GUN. Julius Chein, Montclair, N. J.

1,187,148. PRESSURE INDICATING AND CONTROLLING MEANS. Miller Reese Hutchison, Summit, N. J.

1,187,184. AIR - PIPE COUPLING FOR TRAINS. Fred H. Seely, Creston, Iowa.

1,187,208. DUST-COLLECTOR. Frank X. Wahl, Chicago, Ill.

1,187,209. PNEUMATIC TRACK AND STREET CLEANER. Frank L. Warner, Rockaway Beach, N. Y.

1,187,223. TRAIN-STOP. Simon I. Youngen, Vermilion, Ill.

1,187,277. WINDOW-GLASS BLOWING OR DRAWING MACHINE. Harry E. De Vaughn, Morgantown, W. Va.

1,187,318. AIR - BRAKE FOR VEHICLES. Frank A. Homes, St. Joseph, Mo.

1,187,395. PNEUMATIC HAMMER. Charles H. Shaw, Denver, Colo.

1,187,416. VACUUM-CLEANER. Benjamin R. Chase, Boston, Mass.

1,187,428. CENTRIFUGAL BLOWER AND LIKE MACHINE. Thomas Henry Collett Homershan, Bradford, England.

JUNE 20.

1,187,508. AUTOMATIC AIR - COUPLING. Charles H. Davenport, Elk Park, N. C.

1,187,512. ELECTROPNEUMATIC BRAKE. Edward H. Dewson, New York, N. Y.

1,187,525. AUTOMATIC DAMPER FOR COMPRESSED-AIR REHEATERS OR THE LIKE. Fred D. Holdsworth, Claremont, N. H.

1,187,533. AIR-MODIFYING DEVICE. Anthony V. Keyrouse, New York, N. Y.

1,187,568. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,187,719. VACUUM-VALVE. Alexander Des Rocher, Detroit, Mich.

1,187,758. BLOWER FOR UPRIGHT WATER-TUBE BOILERS. John Magee, Detroit, Mich.

1,187,796. FLUID - PRESSURE GOVERNOR. James G. Zimmerman, Milwaukee Wis.

1,187,835. PORTABLE AIR - COMPRESSOR. Ernest Henry Hill and Harold Hill, Sheffield, England.

1,187,886. DOOR-OPERATING MECHANISM. Wayne W. Brown and John B. Parshall, St. Louis, Mo.

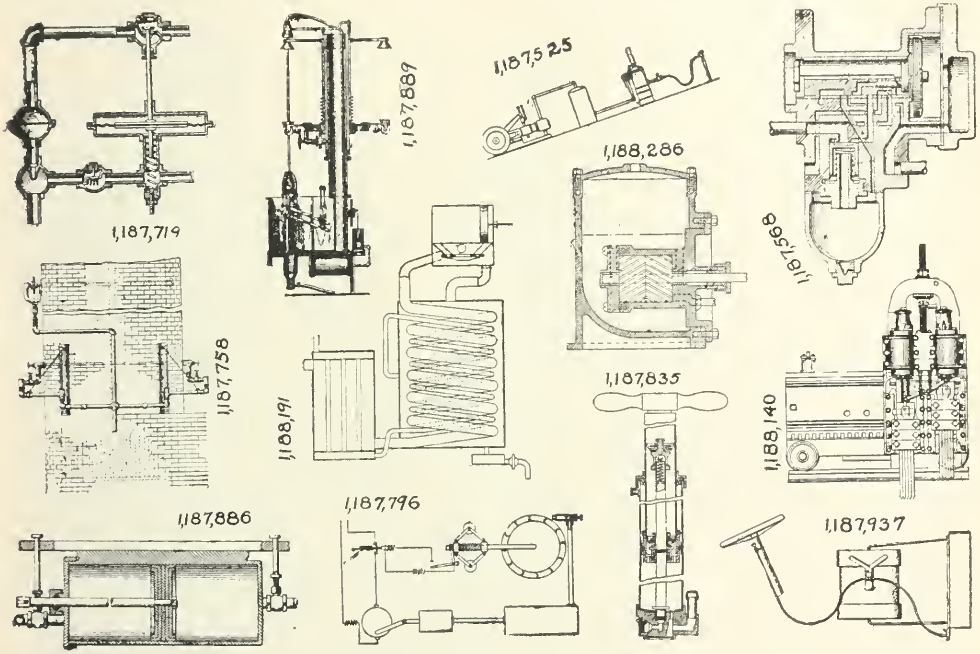
1,187,889. GLASS-BLOWING MACHINE. Vernon M. Dorsey, Laurel Grove, Md.

1,187,937. MEANS FOR SUPPLYING MOISTURE AND AIR TO AUTOMOBILE-ENGINES. Albert N. Stephan, Freeport, Ill.

1,187,938. CAR AND AUTOMATIC AIR-BRAKE COUPLING. Robert D. Stroup, Shyrock, W. Va.

1,188,140-1. CHANNELING-MACHINE. Albert Ball and Henry H. Mercer, Claremont, N. H.

1,188,143. PNEUMATICALLY - ACTUATED TOOL. Albert Ball, Claremont, N. H.



Pneumatic Patents June 20.

1,188,191. PROCESS OF LIQUEFYING GAS-MIXTURES AND FOR SEPARATING THE CONSTITUENTS. RUDOLF MEWES, Berlin, Germany.

1. The described process for separating gases, especially for obtaining nitrogen and oxygen in any degree of purity, which consists in feeding gases under pressure to a point of expansion in counter current to expanded gases coming from said point of expansion, without however mixing said gases, in vaporizing the liquid formed, and in simultaneously alternately heating and cooling the gases given off by the vaporized liquid, substanially as, and for the purpose, set forth.

1,188,286. AIR-PUMP FOR EITHER VACUUM OR PRESSURE. GEORGE I. LEONARD, Los Angeles, Cal.

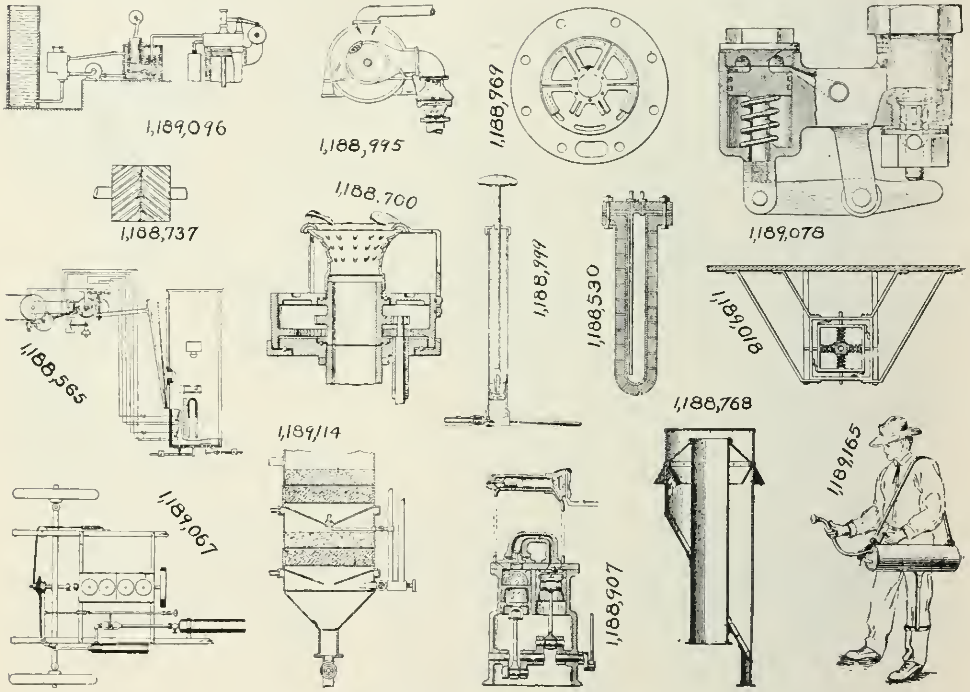
valves adapted to limit the increase and reduction of pressure; and means independent of said valves for varying the range of pressure within the limits for which said valves are set, during operation of the pressure increasing and reducing means.

1,188,700. PNEUMATIC COTTON - PICKER. THEODORE E. STRAUS, Baltimore, Md.

1,188,716. PNEUMATIC ACTION FOR PIANOS AND THE LIKE. CLEMENCE T. BEITEL, Washington, D. C.

1,188,737. ROTARY PRESSURE OR VACUUM PUMP. WILLIAM CLIFTON CUTLER, Sawtelle, Cal.

1,188,768. DUST-COLLECTOR. HERMAN HERMANSEN, Baybridge, Ohio.



PNEUMATIC PATENTS JUNE 27.

JUNE 27.

1,188,530. APPARATUS FOR WORKING WITH HYDROGEN UNDER PRESSURE. CARL BOSCH, Ludwigshafen-on-the-Rhine, Germany.

1. Apparatus for working with flowing hydrogen under continuous pressure and at raised temperatures, comprising an inner vessel which is of itself incapable of permanently sustaining the pressure employed, means for supporting the said vessel to enable it to sustain the pressure, which means are not capable of retaining gas under pressure and means for supplying gases to and from the said vessel.

1,188,565. APPARATUS FOR TREATING DISEASE. MELVIN L. SEVERY, Arlington Heights, Mass.

1. An apparatus of the character described, comprising in combination, a receiver adapted to inclose the body or member to be treated; means for alternately raising the pressure above and reducing it below atmospheric pressure;

1,188,907. PNEUMATIC TOOL. ERNESTO CURTI, Milan, Italy.

1,188,969. VALVE FOR AIR-COMPRESSORS, ETC. WILLIAM F. MEISTER, Marietta, Ohio.

1,188,995. MEANS FOR STOPPING PULSATIONS IN CENTRIFUGAL COMPRESSORS. RICHARD H. RICE, Lynn, Mass.

1,188,999. AIR-PUMP. FRANK I. ROSE, Hastings, Nebr.

1,189,018. AUTOMATIC AIR - COUPLING. CLAUD L. TURNER, Gering, Nebr.

1,189,067. FLUID - PRESSURE ENGINE-STARTER. BIRGE W. DAVENPORT, Minneapolis, Minn.

1,189,078. PNEUMATIC CYLINDER - COCK. OWEN E. EVANS, El Dorado, Ark.

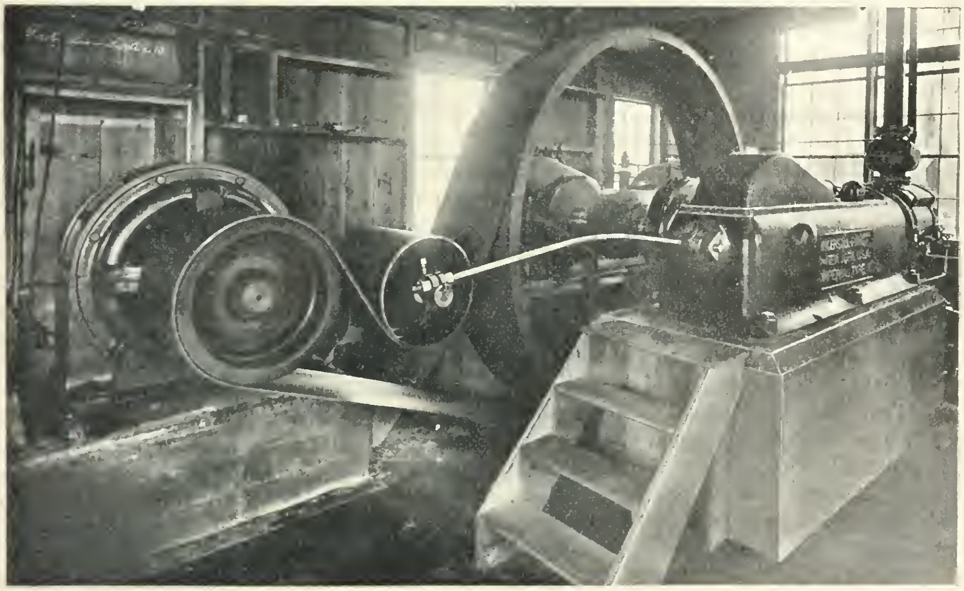
1,189,096. PUMPING APPARATUS. CARL GRUNWALD, Bredeney, Germany.

1,189,114. APPARATUS FOR THE FILTRATION AERATION, AND GASIFICATION OF LIQUIDS. THOMAS KEMPLAY IRWIN, London, England.

1,189,165. COMPRESSED - AIR SPRAYER. WILLIAM NESS, Spring Grove, Pa.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XXI . SEPTEMBER, 1916 No. 9



A TYPICAL SHORT BELT DRIVE.

SOME NOTES ON BELTING

BY FRANK RICHARDS.

Leather belting for transmitting power where rotating machinery is employed is a very old—it is not safe to call anything the oldest—mechanical device, and there seems to be no likelihood of its being discarded. In fact the articles upon belting which are appearing in the current technical press give evidence of a live interest in the topic, which interest is doubtless to be attributed to an increasing and extending employment of belting, and this is easily accounted for by the numbers of electric motors which are getting into steady employment. This extension of the service especially calls for good belting and for correct belting practice.

There are few if any mechanical devices which have so many variable conditions affecting their satisfactory employment, and yet it is a curious fact that, notwithstanding the long years of experience in the use of belting, scarcely one of these conditions is yet taken out of the debatable class. For instance, there are two sides to a belt, which sides it ought to be easy enough to designate. There is the hair side, the side on which the hair grew, and the flesh side, but even these two simple terms are not universally employed. Some talk about the "grain" side of the belt, and immediately I don't know what they are talking about, so that there will be no grain side to any of the belts that I may here present.

WHICH SIDE OF THE BELT?

But, vastly more important than the naming of the belt sides, there is still much question as to which of the sides should be in contact with the pulleys and do the driving. Of course with the surfaces of the two belt sides so different from each other, one must be better than the other for adhesive and driving effect, but there is still much discussion and no decisive agreement as to which to use.

The hair side of the belt as it is manufactured and finished for use is smooth and hard. The pulley surface, if microscopically examined, has minute elevations and depressions, the hard, smooth, unyielding hair side of the belt can only touch the high spots and might not have actual contact with more than one half the surface. The flesh side of the belt is more or less soft and yielding, so that when it is pressed against the pulley, either by the initial tension of the belt or by the actual pull of the drive, it will naturally more completely fill and interlock with the minute, the microscopic, interstices of the pulley surface. The use of the belt with the hair side out has also its better appearance to recommend it. I have used and applied thousands of belts and have never of my own volition used one with the hair side in contact with the pulley. I have of course seen belts enough used in that way, but have never discovered anything but disadvantage in the practice.

For driving efficiency much of course depends upon the actual condition of the surfaces of both the pulley and the belt. The pulley should not be polished but, preferably, as a scraping or wide faced, coarse feed turning tool will leave it. The belt should be treated with a dressing which will soften, and keep permanently soft, the driving surface, at the same time that it shall have no injurious effect upon the inner texture of the leather. I have known sticky dressings applied containing rosin which gave immediate and temporary adhesive effect but which rapidly destroyed the belt by a species of dry rot. A dressing is valuable and effective not by reason of any stickiness but because of its softening and preservative effect. As a general rule, dressings are only thought of when the belt gets so dry and hard that it does more slipping than driving. Belts are dry and hard when they are new, so that dressing should be applied to them at the very beginning. This is done by some manufacturers before the belts are sent out.

It is really astonishing how long belts will last if properly prepared in the first place and if wisely treated afterward. I have known many belts which did not seem to wear at all and gave no signs of growing old. The very best treatment in many cases is simply to keep them clean and otherwise to leave them alone as long as they are all right.

BELT TENSION.

A belt at work does it all by pulling, and the power transmitted by a belt is determined by the tension of the pulley or driving side minus the tension of the returning side. The practice usually followed in sewing or splicing a new belt in place has been to give it so much initial tension that there would always be all the pulling tension on the driving side with some additional tension still in reserve on the returning side.

In the paper on belting by Mr. F. W. Taylor, which was the first paper he ever read before the American Society of Mechanical Engineers, he recommended the actual measuring and adjusting of the tension of the belt, by means of a spring balance or equivalent device, when it is laid in place on the pulleys and previous to its permanent lacing or splicing. In a book on belting recently published by a disciple of Mr. Taylor tables are given to show the "tensions under which a belt should be put to give the most satisfactory results." This is quoted from a prospectus of the book.

Now Mr. Taylor in everything he wrote stated only his absolute and generally his intense belief. There never lived a writer more sincere in his convictions or more sure that they were precisely correct. He wrote only gospel truth—as it appeared to him. Nevertheless, with all due respect to the memory of one whom the engineering world has honored for the good work he did, this about belt tensions, in the light of common sense, and in the light of advanced modern practice, is absurd.

In the first place, the tension of the belt, however correctly it might be adjusted to begin with, would not remain constant. Not only would the belt at once begin to stretch but its length would vary continually with the changing atmospheric conditions. Ignoring the permanent elongation by stretching, the belt on account of the atmospheric humidity might sometimes have too little tension for the driving requirements and sometimes too much.

WHY TIGHT BELTS?

Suppose a belt in its width and thickness to be only a little more than sufficient for the work that is required for it. Suppose it to have such a tension and such elasticity that it will be able to do its work when it is longest and "slackest," then when the atmospheric conditions changed and it became shorter and tighter it would be too tight. It would be overstrained, and most likely beyond the limit of its elasticity so that before long it would be necessary to have it spliced again. The experience of having belts alternately too tight and then too slack if some means of takeup was not provided was a too familiar one in old times, but why have it now?

A belt too tight for the work it has to do is doubly costly. Such a belt must be heavier, stronger, must cost more, than necessary. Say that a certain belt would do all the work required of it with a running pull or tension of 1,000 lb., and say that on account of the tightness of the belt there is a running tension of 500 lb. on the returning or "slack" side of the belt, which assumption is not extravagant as things go, then the actual pull on the driving side of the belt would be 1,000 + 500 = 1,500 lb., this evidently calling for 50 per cent. more strength of belt than would be otherwise necessary.

And here comes in the second unnecessary expense entailed by the tight belt. If the initial tension of the belt is to be depended upon to secure the proper working tension, this must remain in the total pull of the two sides of the belt even when running light and cause unnecessary friction in the bearings. At the best in the case assumed above, with a 1,000 lb. pull on the driving side and little or nothing on the slack side, the pull on the bearings when doing no work would still be 1,000 lb., being then 500 on one side and 500 on the other. In the case with 1,500 tension on the driving side and 500 on the slack side the total pull on the bearings of both the driving and the driven shafts would be 2,000 lbs. This accounts for the lost power which experiments show in driving belted line shafts even when no working power is being transmitted.

There should in fact be no tension on the slack side of the belt when working and there should, theorotically at least, be no tight belts at any time. In addition to this all belts should be automatically adjustable and compensatory for variations of length caused by changing atmospheric conditions. If a belt is used in a horizontal position, or even at any angle up to, say, 45 degrees, with the pulling side of the belt at the bottom and without initial tension in the belt, the sag of the slack side of the belt caused by the weight of it will be sufficient, if proper and sufficient pulley and belt surfaces are provided, to make the belt hug the pulleys and do its work without slipping. If the length of the belt varies on account of weather changes the sag of the belt may be more or less, but until the upper belt actually bows down to touch the lower belt in running it should do its work with perfect satisfaction, but when this limit is reached it will be necessary to shorten and re-splice the belt.

THE SHORT BELT DRIVE.

Better even than the horizontal belt drive as here spoken of is what is now known as the short belt drive. This is to be regarded with the greatest respect, because it is not in any way a makeshift for the saving of space but brings with itself important and substantial advantages. The half tone herewith shows a typical short belt drive. The pulleys are quite close together and with the slack side of the belt so short the weight of it might not be quite sufficient in all cases to give the required adhesion, but a light idler pulley is placed so that its weight rests upon the belt but is so held in position by the rods which are swiveled where they are fastened to the main pillow block that it is free to rise or fall as the varying slackness of the belt may demand. This not only secures the required tension by the weight of the idler pulley but, as will be seen, the belt is carried so far down around the small pulley, in this case the driver, that more than 50 per cent. is added to the area of contact of belt and pulley, which is a valuable item when the pulley is so small.

With belt drives which are so unfortunately circumstanced that the slack of the belt is on the bottom instead of on the top, there is still no excuse for running with a tight belt. An idler can easily be provided in such a case under the belt and so counterbalanced that it will keep up a constant lift on the belt and eliminate the slackness. In the same way a vertical belt of any responsibility should be provided with a floating or self adjusting idler pulley.

The arrangements here spoken of which automatically compensate for the ordinary changes in the length of a belt—after the first working stretch has been taken up—make it generally possible to run belts for a great length of time without re-splicing. This should tend to diminish if not to abolish the use of belt laces. The lace holes in a belt must reduce the strength of the entire belt 25 per cent. or more. The lace makes a bunch which at best cannot run over the pulleys quite smoothly at high speed and the lacing is not lasting—or everlasting—as the body of a good belt is. Good splicing makes a belt continuously homogeneous and "every part as strong as the rest."—*Practical Engineer.*

HUMIDITY AND BELT TIGHTENERS

The following may be taken as neatly supplementary to the article immediately preceding.

Professor William W. Bird, of Worcester Polytechnic Institute, with Francis W. Roys, have been experimentally investigating the effects of atmospheric humidity upon oak tanned leather belting, with the following definite conclusions:

1. If a belt be set up at a low relative humidity, slipping will occur with a marked rise in the humidity, especially if it is accompanied with a rise in temperature.

2. If a belt be set up at a high relative humidity, excessive stretching and excessive pressure on the bearings will result from a decided decrease in the relative humidity, especially if accompanied by a fall in temperature.

3. If a belt be set up at a medium relative humidity the tensions will not be excessive at low relative humidities nor will there be any great danger of slipping at high relative humidities unless accompanied by excessive temperature changes.

4. If a belt be set up at any relative humidity with a spring or gravity tightener, a load 50 per cent. greater than the standard can be transmitted at either high or low humidity without any of the troubles.

PORTABLE MINE HOISTS IN QUARRYING

BY H. L. HICKS.

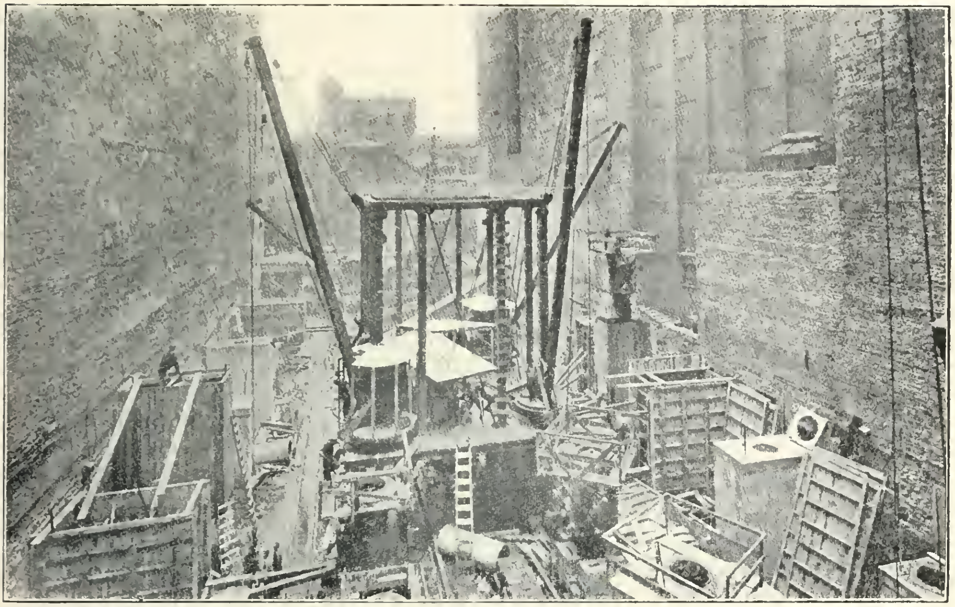
The quarry of the Wetmore & Morse Granite Company, Montpelier, Vermont, is an open pit on one side of which are the power house, derricks and railroad siding. All hoisting and loading work is done on this side. On the opposite side, protected from flying rock by a small stone shelter is a "Little Tugger" mine hoist. This machine (which was shown in Compressed Air Magazine for July, page 8038) is installed for a novel service.

A lot of stone had been worked out to quite a depth and width, and it was decided to widen out the quarry still further before going deeper. The working face opposite the loading derricks was attacked, the idea being to work in terraces down from the top. Due to the lack of railroad siding on that side of the pit the regular derricks on the other side had to break out the loosened stone, allowing it first to roll to the bottom where the derricks could tackle it again.

In "breaking out" the chain sling would slip off quite often and both it and the slack of the inch and a half cable would drop to the bottom. Obviously it was costing time and money to take six men from their work many times a day to haul up the sling and slack of the hoisting cable.

A worth-while saving was effected by installing the little mine hoist spoken of above. It takes its power from the quarry air line, and, being automatically lubricated, it requires practically no attendance. To quote direct "the hauling up of that great chain and cable was lots of fun and remarkably quick."

Later the same people installed a duplicate hoist for such odd jobs as handling drill steel and for putting an occasional man in and out of the quarry. This saved interruption of the productive work of the derrick. The 1,000 pound lifting capacity of the Little Tugger hoist is ample for handling the supplies wanted in the quarry pit.



FOUNDATION WORK FOR ADAMS EXPRESS BUILDING.

A TYPICAL NEW YORK FOUNDATION JOB

The following, which we reproduce, with slight condensation, from *Contracting*, Aug., 1916, page 172, illustrates the principal problems involved in the use of pneumatic caissons for the foundations of the high buildings of lower New York City with, as usual, some conditions and difficulties peculiar to the precise location, some of these being suggested in the opening paragraph.

The new 23-story office building for the Adams Express Co. has a front of about 80 ft. at 65 Broadway, New York, and it has 49 concrete piers sunk to rock by the pneumatic caisson process. The lot, about 210 ft. deep, is bounded on both sides by tall office buildings, and by street lines on both ends. At the Broadway front the heavy traffic made all street obstruction impossible and on the opposite or Greenwich street front the elevated railroad structure, surface car line, and heavy trucking in the narrow street rendered encroachment there almost equally so.

It was, therefore, necessary to make the job self-contained and to concentrate all of the heavy operations within the limited area of the lot, a large portion of which is actually occupied by the foundations, leaving so inadequate a remainder that it was covered deeply with plant and material at best requiring to be shifted more or less and thus necessitating the most systematic procedure and arrangement to carry out the heavy work and install and operate the necessary plant.

INSTALLATION OF PLANT.

Construction operations were commenced by the installation of a Bucyrus steam shovel, which excavated down nearly to water level. After the removal of the steam shovel, an unloading platform was built on the Greenwich street front at one side of the lot large enough for wagons to drive on from the street and deliver materials without interrupting traffic. A contractor's office was also established there, and at the other side of the lot storage was provided for sand and gravel delivered by gravity to a 1-yd. Smith mixing machine installed in the old sidewalk vault and discharging to steel buckets on a narrow-gage service track running the full length of the lot in the bottom of the excavation.

At the opposite end of the lot the Broadway sidewalk was protected by a heavy overhead platform or bridge on which were installed a stiff-leg derrick and a hopper-bottom storage bin to receive soil excavated from the lot and to chute it quickly into trucks driving up in the street and proceeding without stopping long enough to interrupt traffic.

In the excavations were installed two of the contractor's standard tower travelers, each equipped with four derrick booms operated by electric hoisting engines and together covering the entire area of the lot without necessitating their movement. The usual pipe fitting shop, tool shed, and storage houses were installed, quarters for sand hogs were provided, plant and materials delivered for the construction of caissons, cofferdams, and piers. The permanent work was entirely of concrete or reinforced concrete, the temporary work being timber, which was nearly all salvaged.

PNEUMATIC CAISSONS.

The 49 concrete piers supporting the steel columns were sunk with reinforced concrete pneumatic caissons made integral with the pier construction and varying from about 5½ ft. square to 5½ x 11 ft. in plan. The locations were laid out by transit and the inner forms for the working chambers were set on the bottom of the excavation and carefully leveled. The reinforcement rods were then assembled for the working chamber walls and the exterior forms built around them and concreted up to a height of about 13½ ft. above the concrete cutting edge.

The exterior forms were made in full size panels built at the contractor's yard and delivered on trucks to the site. They were of standard construction and uniform dimensions so as to be interchangeable, within limits. They were made in panels each of the full size of one face of the pier from the cutting edge up to the top of the first lift and built of tongue and groove vertical boards nailed to outside horizontal cleats. When assembled together, they were held in position by horizontal ½-in. rods from 3 to 4 ft. apart, passing through vertical outside bearing pieces from 2 to 3 ft. apart.

A 4 x 4-in. horizontal wooden cleat was lightly nailed to the inside of the wall on all four sides 1 ft. below the top and permanently imbedded in the concrete, the panels being easily separated from it when they were stripped after the concrete was 48 hr. old.

AIR SHAFTS.

In this work access to the working chamber was afforded by a 3-ft. circular well formed in the concrete pier and used without any lining, thus eliminating the expense of a permanent steel shaft or the necessity of installing and removing a collapsible one. The concrete was cast around an interior cylindrical core about 8 ft. long made with 1½-in. tongue and groove vertical staves with their edges carefully dressed for radical planes.

The cores were made up in two semi-cylindrical parts with circular inside rings of 6 x 1-in. steel; each of them made with two halves having the ends bent 90° radically to form interior flanges through which the two semi-cylinders were bolted together with separators. This on one side was a 6 x 1-in. board and on the other side a wedge-shaped sleeve made of a 6 x 4-in. timber tapered to 1½ in. at the outer edge. The two semi-cylinders, each corresponding to an ordinary horizontal arch centering, were bolted together with the separators, forming a complete cylinder around which the concrete was cast. After the latter had set, the flange bolts were removed, the wedge withdrawn, and the centering removed without difficulty.

Around the upper end of the shaft there were imbedded to a depth of about 14 in. in the concrete, twelve ¾-in. vertical bolts which projected 2 in. above the surface of the concrete and received the bottom flange of a riveted air shaft which was screwed tight down on a gasket, making a strong, airtight connection that was found perfectly satisfactory. To the upper end of the air shaft was assembled a standard air lock for the passage of men and materials. The steel shaft was provided with the usual ladder, and horizontal steel rungs were embedded in a recess cored out of the pier concrete to correspond on one side of the shaft below the bottom of the steel.

SINKING CAISSONS.

Air pipes built into the concrete caissons were connected up to a supply main 6 in. in diameter from the contractor's power plant which was furnishing compressed air for driving tunnels across the East River. Although a main about 2,000 ft. long was required, it was more satisfactory to lay it than to install a compressor plant in the restricted area at the site. Air was thus delivered in unlimited quantities at a pressure of about 20 lb. per square inch, which was in excess of that required for the average depth of sinking, *i. e.,* about 30 ft. below water level.

The piers were built with 1:2:4 gravel concrete, of which about 3,000 yd. was required. The concrete was made with Whitehall brand stripped and cofferdams about 15 ft. high were built on top of the piers. Each cofferdam was made of four full-size panels similar to those used in constructing the forms for the working chambers. These were placed over-lapping the upper end of the concrete piers far enough to cover the 4 x 4-in. horizontal wooden cleats embedded in the concrete to which they were spiked, securing them in position, where they were further held by tie rods in the usual manner. The lower ends of the vertical boards in the panels were chamfered to a sharp edge to diminish the resistance in sinking

The caissons were properly braced and guided and were ditched as far as convenient, after which air pressure was put on and they were sunk in the usual manner through clay, quicksand, and two strata of hardpan having a combined thickness of about 8 ft. and separated by a bed of clay and gravel. They were sunk to bearing on the bedrock which has an approximately horizontal, regular surface. About five caissons were under air pressure simultaneously and they were sunk at the rate of about 1 ft. per hour.

The caissons were loaded with 2-ton cast iron blocks piled around the steel shafts inside the cofferdams and conveniently shifted from pier to pier by the traveler derricks as the work progressed.

COFFERDAMS AND SHEET PILES.

The cofferdams served as forms in which the upper lift of concrete was deposited to the required level, several feet below the top of the cofferdams. The cofferdams remained in position until after the sinking of the caisson was completed, and the remainder of the excavation was made by hand to a depth of about 10 ft. below the original groundwater level. The upper parts of the cofferdams were then removed, leaving the lower parts imbedded in the ground.

The rectangular wall caissons have a space of about 9 ft. between their adjacent ends, thus leaving open panels between the wall caissons of a combined length of nearly one half the perimeter of the lot. In order to facilitate the excavation of the site to a depth of about 10 ft. below water level these openings were closed by tongue and groove wooden about 15 ft. long driven between the caissons after the latter were sunk to position. This afforded a seal of several feet below the bottom of the pit and enabled the excavation to be completed with much less pumping than would have been necessary without the formation of the cofferdam.

The work was executed by the Flinn-O'Rourke Co., contractors, with a force of about 175 men; James O'Rourke, superintendent.

THE BUSINESS OF MINING

BY W. R. INGALLS.*

Mining is a business. It should be so regarded. You should consider yourselves as business men. You are not going to be any better or any worse than other business men. You are not going to have any professional dignity to uphold that the honest stockbroker or the conscientious manufacturer of woolen goods has not got to have in mind. Both of them may be just as honorable men in business as are miners and smelters. There is no greater fallacy than when it is told of the miner that he, like the farmer, is one of the producers of clean wealth for the reason that coming out of the ground it does not come out of anybody else, with the implication that other kinds of wealth are more or less tainted. The value of minerals in the ground inherently is nil. One hundred million tons of gold ore in Antarctic lands might not be worth any more than sand in Florida. By the expenditure of work in overcoming the obstacles of nature, it might become worth a great deal. All wealth is the result of human labor, generally assisted by capital, which is the result of previous labor. The wealth accumulated by the Standard Oil Co. by economies in manufacturing and marketing is just as clean as the wealth that the miner produces out of the ground. The banker, the broker and the merchant is just as necessary and just as honorable a man of business as is the producer, and men of business who talk in terms of profit are just as honorable as professional men who talk about fees and engineers who pride themselves upon not being concerned with commercial considerations.

---

*From Annual Commencement. Address, School of Mines and Metallurgy, University of Missouri, May 26, 1916.

The mistake that is most often made in business is to suppose that we grow rich by taking riches from other men, or that nations prosper by depriving other nations of their prosperity. That would be true if riches consisted only of money, and if there were just so much money and no more in the world. But that is not so. Nations grow rich, that is to say, get comfort, ease and luxury, only when other nations are growing rich too, only because other nations are growing rich. And so it is with individuals.

Consider, therefore, that in going out into the world from this school you are going into business—the business of mining, which is a very interesting business. Consider that you are going into business to create wealth, for if you do not create wealth you will have a hard time of it and might as well not try it. At first you will probably have to make money for an employer and a portion of what you make for him will come back to you as wages or salary. The cycle may not be obvious. It may be delayed. But the principle exists and always will. You will see many things done in ways that by book they ought not to be. You will observe many examples of crude mining, of muscular metallurgy—less now than a quarter of a century ago. But if muscular metallurgy makes money and refined metallurgy does not, obviously muscular metallurgy is the thing to do, for otherwise there would be no bank account and on pay-day there would be gloom. Keep that principle in mind, but observe always and think whether by doing the right thing an improved metallurgy would not make *more* money. Look at things always from the standpoint of the business man and not from that of the pedant and doctrinaire. Rub against your fellowmen. Build up your character. Don't be afraid to take chances and accept responsibilities. And when the battle is over, let your friends be proud to read an epitaph like this:

Here lies one who took his chances
In the busy world of men:
Battled luck and circumstances,
Fought and fell, and fought again;
Won sometimes—but did no crowing,
Lost sometimes—but didn't wail;
Took his beating—kept on going,
Never let his courage fail.

A PORTABLE GASOLINE-AIR OUTFIT DRILLS ANCHOR-BOLT HOLES

BY H. L. HICKS.

The New York Edison Co. has under construction an electric transmission line from Elmsford to Croton Lake, N. Y., a distance of 18 miles. For the greater part of its length it follows the line of the Catskill Aqueduct, and this eliminated the work of clearing the right-of-way.

The latticed steel towers are to be spaced at 400-ft. intervals and will be 60 ft. in heighth, except at angles and curves in the line where 70-ft. towers will be erected. The foundation work has been in progress for the past six months. The towers are to be bolted to 6-ft. steel anchor bolts, or "stubs," embedded in reinforced concrete. These stubs are 2 in. in diameter and are without heads, dependence being placed upon the holding power of the corrugated surface of the steel. The right-angle flanges to which the towers will be bolted are 3 in. wide by 12 in. long and are drilled for six ¾-in. bolts.

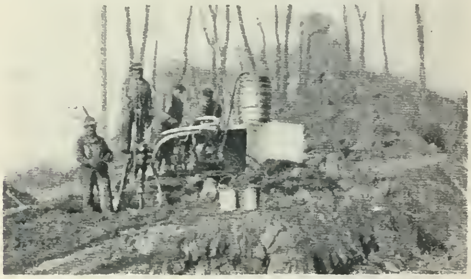


FIG. 1.

In laying out the line it was found that at 12% of the locations rock would be encountered. This necessitated the setting of many of the stubs in solid rock and drilling for the purpose large-diameter holes up to 5 ft. in depth.

The large amount of hole drilling made it advisable to employ machine drills, and the Ingersoll-Rand "gasoline-air" drill was selected for the work.

This is the first recorded installation of this type of drill in this section of the country. The gasoline-air drill (Fig. 1) consists of a tripod-mounted piston drill operated by a pulsator similar to the Temple-Ingersoll electric-air outfit. The pulsator in this case is driven by a 6- h. p. single-cylinder gasoline

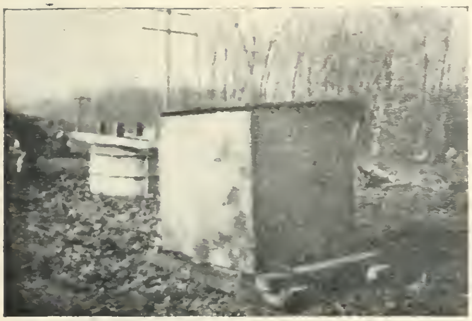


FIG. 2.

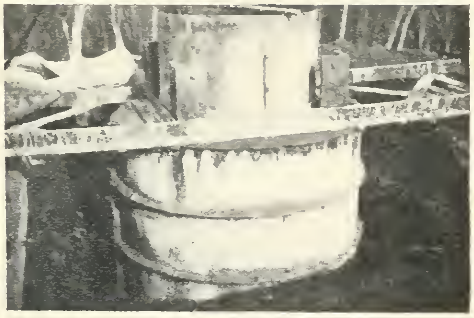


FIG. 3.

motor which with fuel tank and pulsator is mounted on a small wheeled truck. The drill is reciprocated by pulsations of air acting in a closed circuit on alternate sides of the drill piston.

The pulsator unit weighs about 600 lb., the comparative lightness and compactness being a great advantage under the conditions.

For convenience in handling on soft ground the truck mounting the engine and pulsator was fastened to skids (Fig. 2) and a removable wooden housing provided as a protection from the weather. The entire outfit was transported by wagon.

Bedrock was uncovered and the drill set up in the excavation. Particular care in setting up was necessary to keep the drill vertical and the four holes accurately spaced. The rock was very seamy. If the hole started to run off, pieces of iron were wedged around the drill steel to correct this.

Collapsible steel forms were set up, the stubs were grouted in the drill holes and the concrete then poured. The anchoring stubs were spaced 2½ ft. each way, being located by a templet and so held in place until the concrete had set (Fig. 3).

The circular concrete foundation is 3 ft. 10 in. in diameter with a hollow core 2½ ft. in diameter and projects 6 in. above the ground. This center space is subsequently filled with spoil. Where no rock is encountered, the concrete is extended to the full depth of 5 ft.

Observations of the performance of the gasoline-air drill in drilling a group of four holes showed a total of 21 ft. of drill hole in 4 hr., including the time of changing set-up and squaring the layout of holes. These observations were made on a day when the temperature ranged from 10° at 8 a. m. to 24° at noon. The fuel consumption averaged 1 gal. of gasoline and ⅕ pt. of oil per 10 ft. of drill hole. Crossbits were used, with drill holes bottoming at 2¾ in. The labor expense consisted of a drill runner at $2.50, a helper at $2.00 and an engine operator at $2.50 per day.

As the drill is operated intermittently, and the drill crew is employed part of the time on other work, it is rather difficult to make up any accurate statement of the operating cost per foot of drill hole.

THE CEMENT GUN IN MINING WORK

The American Zinc Co. of Tennessee purchased a cement gun to cement the bottom of a creek wherein crevices occurred which let water into the mine workings. That work has not been begun yet on account of the water in the creek being too high, but probably it will be started at an early date.

In the meantime the gun has been used to cover many crevices in the mine where water entered during rainy periods. The procedure has been to cover a crevice with triangular mesh wire, fastened along the edge of the crevice with pieces of steel, small rocks being used inside to give backing to the gunite. Then with the gun mixture of cement and sand spread over the wire, it has resulted in making the crevice water-tight. The gun will not work against flowing water, so the crevices must be taken when they are dry.

The gun has been very useful in finishing concrete bulkheads, making them water-tight all over, and especially joining them to the sides of the drifts. Also some encouraging work has been done by cementing cracks in the roof of the mine which threatened to enlarge and cause slabs to fall.—*Eng. and Min. Journal.*

GROWING APPRECIATION OF NITROGEN

Persons who talk of the importance of chemistry in this war are usually talking of one thing only, though they may not know it—and that thing is nitrogen. The chief chemistry of the war is practically centered on nitrogen. Recognizing this fact, it is strange to think that we live by breathing an atmosphere containing 80 per cent. of this element which in certain combinations is dealing out death on an appalling scale in all the fields of action. There are practically no useful explosives employed in which the action of nitrogen is not concerned.

NITROGEN THE DESTROYER.

Without its aid the great ships at sea could not be sunk, or innocent victims on land killed. or property destroyed by the aeroplane and dirigible; while it serves to mow down whole columns of men in the field, for rifles, howitzers, machine-guns, and grenades are all dependent upon, and made terribly deadly by, the offices of nitrogen. We every day pass on to our lungs something like 450 gallons of nitrogen per 24 hours, which would be enough to make 30 pounds of tri-nitro-toluol, or 40 pounds of gun-cotton.

NITROGEN ONCE LITTLE THOUGHT OF.

In our early training in the elements of chemistry we were wont to regard nitrogen as a singularly uninteresting gas on account of its negative behavior. It did not burn like hydrogen, it did not support combustion like oxygen, and, in short, its presence was generally assumed because of its inactivity and because it did not directly respond to any test. And yet this element is the greatest of all as a munition power; it is hardly an exaggeration to say that applied nitrogen is going to be a factor in deciding the issue of the war. It is remarkable, also, that this element forms the central figure in the protein group or tissue-repairing material of our foods. To say that without protein we die, practically means that without nitrogen we die. The gas without positive tests is as necessary in one form for our support as in other forms it is ready to destroy us. Nitrogen's power depends in the first place on the fact that it carries in oxygen to compounds which are thus rendered explosive, turning all the elements into a huge volume of gas, itself being set free. The very inertness of nitrogen, or its objection to affinity, means that on the least provocation it will easily release its partner oxygen, handing this over to the combustion of other elements present, with the formation of volumes of gases, the nitrogen returning to what is apparently its congenial condition, the free state. As a fertilizer in the soil nitrogen acts as a stimulant and supplies the necessary nitrogen to the plant. In other words, it is a plant food. Thus the remarkable thing about nitrogen above all other elements is its power to destroy life or to sustain it according to the associates with which it is in company. With certain accomplices it forms death-dealing explosives, with others it becomes a nutritive material. It is the essentially romantic element, devil or god, according to its associations.

NITROGEN OR WE DIE.

NITROGEN THE PLANT FOOD.

"AIR BLASTS" IN MINES

The question as to the nature and origin of the phenomena known as "air blasts" in metalliferous mines, especially in India, has for years past been the subject of close scientific study, but there is still a good deal of mystery associated with it. Attention is drawn to the subject in a very striking way by what has recently occurred at the Champion Reef mine in India. For the second time within little more than two years it has been found necessary to suspend operations in considerable sections of the property, regarded as the danger zone, in the hope that the air blasts will in time wear themselves out, or, in other words, that the mine will fire itself off, if it wants to do so.

NOT AIR BLASTS.

At a recent meeting of one of the gold mining companies Mr. Edgar Taylor said it was a misnomer to call these phenomena "air blasts." There are no harmful gases in any of the Kolar mines; it is entirely a question of rock tension. Every possible effort is made to minimize the effects of these air blasts, which occur in places where the ground has been excavated, either in levels or in slopes, or, unfortunately, sometimes in shafts.

An enormous amount of filling is done—filling with waste rock—and the timber is constantly watched to see where any movement of the rock has taken place, and broken timbers are always replaced. Years ago we put in boreholes, not for the purpose of relieving gases because there are none, but for the purpose of seeing if we could relieve the tension of the rock.

The Chief Inspector of Mines in Mysore dealt with the subject at considerable length in his report for 1913-14. For some years past, he said, the most strenuous efforts have been made to cope with these dangerous and difficult phenomena. Timbering has been increased to an altogether unusual extent, systematic filling has been in progress for years, and portions of the mines which are considered to be particularly liable to danger have been closed or abandoned. Our trouble is that we really understand so little about the precise nature or origin of so many of these blasts or quakes, and another lies in the fact that any particular line of action may take so long to make its influence felt, and the results may be so obscured by a variety of complications that it is often impossible to say whether an improvement is being effected or not, or to what precisely any improvement may be due. There is one and only one way to avoid entirely accidents due to air blasts, and that is to close the mines down altogether. That would be like curing a man of being sick by cutting his throat, but the position by no means warrants any such drastic procedure.

FATALITIES NOT HEAVY.

Taken over a number of years, the average fatalities are by no means very excessive, though regrettably high. Although there can be no question of closing the mines as a whole, there may be good reasons for closing certain portions which are believed to be specially liable to danger, or which present features that are considered to be undesirable according to our present lights.

If we consider the great uniformity of the rocks throughout the Kolar Field it is difficult to understand why these air blasts should be so markedly concentrated in Champion Reef. The fact that veins dip less steeply in Mysore, which has been on the whole comparatively free from these shocks, and much more steeply in Champion Reef and Ooregum, which have suffered most, does not appear to help us, but rather the contrary. About 10 years ago, when these phenomena began to attract serious attention and I took up a serious study of them, the southern portion of Ooregum was, I think, the most affected region. Since then the Champion Reef has taken the premier place in this undesirable contest, and in view of the general uniformity of the rocks one seeks for other features in which a maximum or minimum is reached in the most affected areas. A study of the underground workings shows that in Champion Reef down to the 25th level we have the area of maximum intensity of stoping for the whole field. Although in the Mysore mine a greater bulk of rock has been removed, the stoping has been spread over a wider area, or rather series of areas, with intervening patches of solid country, whereas in Champion Reef stoping has been almost continuous from one end of the mine to the other from about the 19th to the 25th level, and whether the conclusion is justified or not the association of this feature with the increase of air blasts in this zone is a reasonable hypothesis in the investigation of an intricate problem.

As the result of detailed discussion of the problem with the superintendent of the mine it was decided to shut down the whole of this large section of the mine. Enormous quantities of waste rock have been put into these stopes for some years past, but this has not sufficed to check the air blasts; on the contrary, they have increased. We hope that in the course of time the air blasts will tend to wear themselves out, and that the fractured hanging wall will rest comfortably and securely on the filling. It may then be possible to attach the valuable ore reserves in the area. It may not be realised what a decision of this character may mean from a mining point of view, and it may be well to note for the information of those who appear to think that the mining companies take no trouble, or shirk expense, to avoid accidents, that the closing of this section means the locking up of a good deal of valuable ore which has already been developed and opened up, and from which a quarter of a million sterling, or more, could be easily and cheaply extracted. How long it will remain locked up, or whether it will be lost for ever, must be left to the future to decide. In pursuance of the same policy endeavours are being made to prevent a repetition of the special circumstances of this case and to arrange for working in distinctly separated blocks. In many cases this is easy enough, as the shoots are usually separated by large patches of barren ground, but the idea is to go farther than this and to divide up the shoots themselves into alternate stoping sections and huge pillars. From a mining point of view it may not be easy to carry this out, and the problem of attacking the huge pillars will then remain. The scheme is, however, under discussion, and I hope that in default of anything better it will be possible to introduce it with appropriate modifications to suit the circumstances of different mines.

With regard to the filling of stopes, at any rate on the steeper portions of the veins, the practice of taking the stopes down a certain distance and then putting in a stull and filling above it before continuing the stope in depth has been discontinued for some time past. These stopes are now carried down the whole depth of 100 ft. or so from one level to another without any filling, but with stulls at intervals covered with heavy lagging so as to catch up pieces which may fall or burst off. In the case of an air blast some or all of these stulls might be broken or thrown out, but our experience has been that the same thing occurs even when filling has been put in above, only in the latter case the filling is likely to go to the bottom and increase the mess and the difficulty of rescue. The main reason for the change of procedure is that in filling shallow sections of stopes there is great difficulty in securing complete filling and compactness in these shallow sections, with the result that at the end of it all the filling is not of much use, and does not help to support the hanging for a long time. This means heavy pressure on the unstoped margins for a long time, and tending for the hanging to continue to fracture. Under the present scheme, when the stope has been completed to its depth the filling is shot right down from top to bottom, forming a much more compact mass. This is done before the next section of the stope is taken down, and so far as we can judge the scheme has been satisfactory. I have referred to this before, but I do so again in order to suggest that this more effective filling may be producing some beneficial effect in regard to the general tendency for quakes to occur in stoped areas. As I have already said, we cannot expect to get rid of air-blasts and quakes. In discussing these phenomena some years ago I endeavored to distinguish between air-blasts and quakes both in regard to intensity and mode of origin. Since then the air-blasts or the bursting of rock as a result of internal strain and unconnected with pressures developed by the stoping out of large areas have shown a tendency to increase in violence. At any rate, much more violent bursts are now known and recognized than was the case 10 years ago. This appears to be quite local and sporadic, but the fact that they are sufficiently violent to break large quantities of rock and to fracture timbers suggests that many quakes which occur in the neighborhood of pillars in stoped areas may sometimes be due to the same cause and not merely to strain or fracture caused by excessive superincumbent pressure.

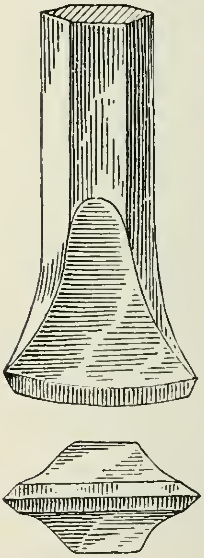


FIG. 1.

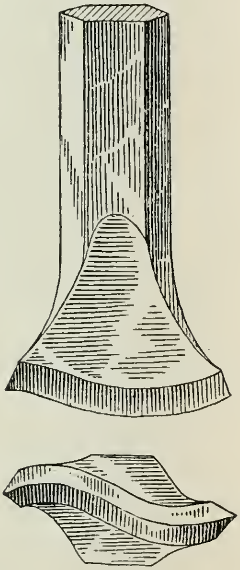
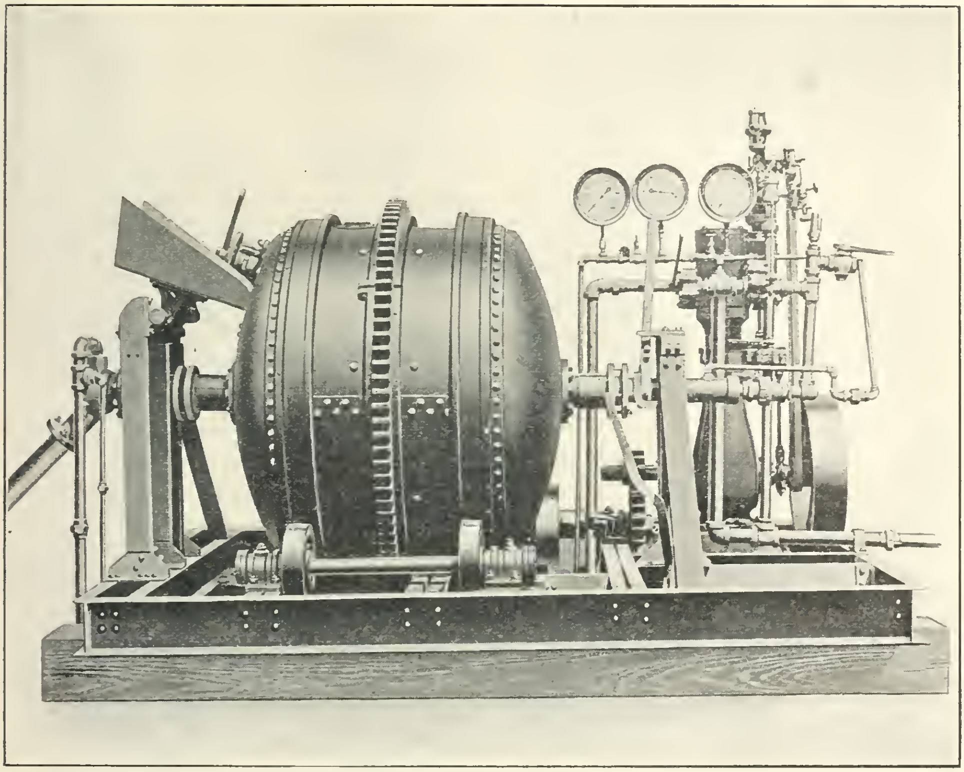


FIG. 2.

DRILLS FOR CRACKED ROCK

Sometimes when a miner encounters seamy or broken ground, especially when it is composed of hard, shattered rock, the ordinary drill, sharpened as shown in Fig. 1, does not give good results, for the edge is frequently driven into a crack so that it is practically impossible to loosen or remove the drill.

This difficulty may be overcome by sharpening the drill as shown in Fig. 2, where it will be seen that the corners have been turned back so that the cutting edge assumes a curved outline. Such a drill point as this will ride over ordinary cracks and thus prevent sticking.—*Coal Age.*



CONCRETE MIXER AND PNEUMATIC CONVEYOR.

A NOVEL COMBINED CONCRETE MIXER AND PNEUMATIC CONVEYOR

We reproduce on this page an excellent photo of a novel and interesting and successful machine for the combined purpose of mixing, conveying and placing concrete as now so largely required in engineering construction.

The essential feature of the machine is a large cylindrical drum with horizontal axis, driven by an independent engine or motor. It contains mechanical mixing apparatus and special appliances for delivering the mixed concrete to the outlet through which it is forced by pneumatic pressure while the drum continues to rotate. After a batch is discharged the machine is stopped, recharged through the hopper then started again and so on continuously.

The trunnion outlet may be connected to a pipe from 2 in. to 8 in. in diameter, according to the capacity of the machine, through which the concrete is discharged in a continuous steady stream, with an air pressure of only 15 to 20 lb. per square inch. This pressure is maintained steadily and uniformly, and is free from the fluctuations of from 5 to 40 lb. that have obtained in pneumatic distributing machines. The steady output of concrete doubles the capacity of the machine and reduces the amount of compressed air by about 50 per cent. per volume of concrete placed. A remarkable feature of the machine is its ability to discharge concrete made with 1 in. stone through a 2-in. pipe. Concrete with 1½-in. stone can be discharged through a 3-in. pipe, 2-in. stone concrete through a 4-in. pipe, and concrete made with run of crusher stone through a 6-in. pipe.

Machines fitted with 2 or 3-in. discharge pipes distribute the concrete to a total horizontal distance of about 500 ft. and a vertical height of 90 ft., while the larger sizes, with from 4 to 8-in. discharge pipes can place it 3,000 ft. away horizontally and 100 ft. high.

The machines are operated by a single man, exclusive of those supplying material, and up to and including 4-in. discharge pipe, have a capacity of from 20 to 50 yd. of concrete mixed and placed in 8 hr.

The discharge pipe terminates with a rubber hose of the same diameter which for the smaller machines can easily be handled by one man and operated easily without any kick in the pipe. The hose is, of course, eventually worn out by the concrete, but its life depends largely on the quality of the rubber lining and has been found to be as great as 4,000 yd. of concrete for an 8-in. pipe. A machine proportioned for a 2-bag batch of concrete and having a 3-in. outlet can discharge in 10 sec., against 20 sec. required for the same amount of concrete mixed in the old machine with an 8-in. outlet.

The large new machine has a capacity of about 500 yd. of concrete in 8 hr. when conditions are favorable. A 2-bag machine, 3-in. outlet, weighs complete about 8,000 lb. and is operated by an 8-h. p. engine or motor. The best results are obtained at a speed of about 16 r. p. m. and concrete of any degree of consistency can be handled successfully with it. Enough water to prevent it from sticking to a wheelbarrow when the latter is dumped is recommended.

The machines have been invented, developed, patented, and improved by James H. Graham, and are placed on the market by the Pneumatic Placing Co., Inc., 2 Rector St., New York.

THE ATMOSPHERIC PROBLEM IN THE DEEPEST MINES

The mines spoken of, the deepest working mines in the world, are in Brazil. The problem of reaching depths considerably greater involves mainly the question of hamer endurance. The matter is interestingly discussed in the report of G. Chalmers, superintendent of Morro Velho mine of the St. John del Rey Mining Co., Ltd.

The system of distribution of the air, says the report, is becoming, as greater depth is attained, defective and requires modification. On rare occasions the downcast air at the bottom of the mine is comparatively low in moisture, by the time it has passed over two horizons. Consequently the efficiency of the men on the stopes above is considerably impaired; in fact, 86° wet bulb (which represents the conditions of, say, horizon 16, at any rate during the rainy season) is supposed to be the limit at which men can work with full efficiency, and as the mine deepens this will, of course, be more seriously felt. But by largely increasing the volume of air passing through the deepest explorations, and by leading the allotted quantity (after it has passed over the stopes of one horizon, or at the outside two) directly to the upcast and away to the surface, instead of passing it over the stopes above as in the old and existing system, the best possible conditions will be obtained.

Due to the fact of our now being in a much better position as regards the mainway into depth, namely, of its being in advance of the explorations, Captain Watts has proved that it is possible to work each block by one vertical winze only, and our calculations show that this one winze and a steel pipe of 3 to 4 ft. in diameter will, with the eastern paved airway, give ample ventilation to the stopes during the working out of a block of mineral. Consequently, one winze for mineral and filling to act as a temporary upcast, which during the working out of each block disappears as the mineral is removed, is sufficient for the mining operations, and by sinking another vertical winze from one horizon to the other, never less than 50 ft. from the average line of the north wall of the lode, and some connecting tunneling, a permanent return airway will be formed at a cost no greater than that of the old system of working out each block with two vertical winzes and a western wood-block airway and the eastern paved airway, as the large saving in the temporary western airway in the form of a 3 to 4 ft. steel pipe over the wood-block airway formerly used is more than sufficient to pay for the tunneling between the top of one permanent upcast winze and the bottom of the next, and that connecting the temporary winze with the permanent. There is another advantage in this system—namely, that when it is completely established we have a second permanent way into depth from horizon 17 down.

It was difficult to determine the point at which the improved system should commence, but for various reasons No. 23 winze offers the best opportunity for an independent upcast airway, and consequently it has been decided that the new system should commence from this point.

The benefit of the proposed alteration in the ventilating system will not be felt on the blocks of mineral to be worked out from horizon 17 up, but from 17 down. Those of us who have been responsible for the reopening of this mine from surface to its present depth of 5,826 ft. have had the opportunity of realizing the steady rise in temperature as the depth has increased and have been frequently reminded of the difficulties in store for us, especially at such times when an inadequate volume of ventilating air had been passing over the stopes or through explorations, caused by the partial closing of airways, the failure of fans, or by the explorations progressing more rapidly into depth than the main ventilating system. However, for many years it was possible to keep down to a reasonable figure the temperature to which the miners were subjected, and it appeared that by increasing the volume this condition could be maintained.

In the first place, natural ventilation was sufficient, later, furnaces had to be adopted during the hot season to assist the natural ventilation. As the mine became still deeper a Capel fan was installed at the top of the upcast "C" shaft to ensure a more constant volume of air. Finally, a Sirocco fan of large capacity was installed in place of the former, the output of which could be increased by additional power when required. Besides this, auxiliary fans are used on all explorations beyond the main system.

The existing ventilating system, which is referred to above as not satisfactory at the present depth, was forced upon us at a time when a more elaborate one of an entire independent airway from surface down, which naturally recommended itself, would have been too expensive. The former represented the cheapest means of ventilation, and until quite recently met the case satisfactorily. As depth has been attained the necessity for modification in the distribution of the air becomes imperative. The lode has so far shown no signs of failure in size or value in the lowest explorations. The prospects of this company being able to work it profitably to a great depth seem only to be limited by cost of winding, hauling, handling, mineral, and other engineering matters.

It was decided some years back to institute investigations with the object of obtaining information as to the increasing air and rock temperatures and add to cost the deeper the mine is sunk. Bore holes were made, and the temperatures taken.

From the temperature readings we were able to construct a rock temperature grade as a guide to what we might expect in depth.

As before stated, without this rise in temperature from the rock and other causes, the probable running engineering expenses in working the mine down would not mean a very serious increase, and this has proved itself in practice as far as we have gone. Supposing the lode continues the same in size and value to horizon 20 (a vertical depth of 7,626 ft.) it could be worked profitably to that point and even to a much greater depth, but from the grade on our temperature chart the rock at horizon 26 would be no less than 126.5° F. at the moment of opening.

We have, of late, realized from practice that the best we can now expect in the absence of artificial cooling would be a point where the efficiency of the men would be affected.

The temperature of the rock that had been laid open and exposed to the ventilation for some time year by year fell to some extent, but the deeper we went the cooling effect of the ventilating air would become less efficient, as we were year by year largely increasing the rock area; but beyond certain reasonable limits we could not increase the volume of the air, and consequently, unless the air could be artificially cooled on surface, advantage being taken of the operation to deprive it of some of its moisture, the possibility of working the mine to horizon 26 would be small, unless the working hours were reduced by the introduction of four shifts in the place of three. It was decided to make further efforts in obtaining more reliable information as regards this important question so as to arrive at the most economical and efficient means of reducing both the temperature and moisture of the atmosphere within the mine.

The increase of air temperature, due to the air becoming more dense as it passes down the mine, showed under normal conditions an increase in rock temperature of approximately 1° F. for every 180 ft., while the increase in rock temperature is approximately 1° F. for every 125 ft.

During the cold season an experiment was tried by night, when the temperature was considerably below the normal, in which a known volume of air was passed through a measured distance of the adit tunnel into the mine, the rock temperatures being taken throughout the distance of the tunnel and period of trial, and at the end of 5 hours it was interesting to find that a considerable fall in the rock temperature had taken place, and it would no doubt have continued to do so to some extent had it been possible to maintain a supply of cool air, but as the sun rose the air became warmer and the rock rose again to its original temperature.

The drying of the air has always been considered necessary in conjunction with the cooling operation, but its importance was not so fully understood until information was gained from a valuable paper by Prof. John Cadman. Unfortunately, the drying of the atmosphere is somewhat antagonistic to a satisfactory solution of the dust question, which necessitates watering of the roads and stopes to keep down the dust. However, the proposed distribution of the air, previously referred to, will apparently do far more to overcome the dust trouble than the drying of the air will make against our efforts in this respect, as the allotted quantity of air, after passing one stope or at the outside two, will go directly with what dust it has taken up, to the upcast and away to surface, instead of the present system, in which the same air passes the bottom stopes, thence over the remaining stopes, with some slight addition of fresh air at each horizon, but accumulating dust all the way, until it finally reaches the highest stope, and thence goes to surface.

The actual necessities as regards cooling and drying to ensure that as greater depth was attained the miners would work in a perfectly healthy atmosphere (even more so than in the upper sections) having been appreciated, the next point to determine was where the operation of cooling and drying should take place. Some advice had been offered to the effect that it would be most advantageous underground, and it is true that some benefit would be derived from this; but the increase in mechanical appliances underground represents a serious obstacle to our particular form of mining operations, and, further, on account of our principal cooling agent (water) being found on surface in abundance, while underground there is very little, and that at a high temperature it has been decided that the cooling plant should undoubtedly be installed on surface.

Eric Davies, whose duty it has been to carry out the investigations, has also been entrusted with the designing of a plant which we consider most suitable for the purpose, and careful study has led to the proposing of this plant, not for extreme cooling or drying of the air, but one in which each operation will be performed to the most economical point, at the same time making use of ordinary cooling appliances which in practice have long since proved their reliability in cold storage, dry blast for furnace and other installations, and in consequence it represents a thoroughly practical scheme, which will effectually remove the one serious obstacle against the company being able to work the mine to a great depth. As regards the necessary power for driving the plant, this is not excessive, amounting to approximately 400 h. p., and as to the provision of this power, with that of 200 h. p. for ventilation, and other additions necessary for the working into depth, it has been satisfactorily arranged for.

The mine captain considers the efficiency of the miners is very little affected so far, and the writer is inclined to think that men who have been used to the damp, hot climate of Brazil for some years are probably more capable of working efficiency in 86° wet bulb temperature than men in England accustomed to a damp, cold climate on the surface. Often enough in the hot season here the change from surface to the bottom of the mine is only slight, but the change in England would, of course, be a far more severe trial. Even in the hottest places in the mine the contractors are eager to work 12 hours, and had it not been for our complying with this to some extent we should have lost our men. It is, however, evident that in spite of the apparent possibility that this climate is favorable to the efficiency of men working in hot mines, 8 hours is quite sufficient for steady workers at the present depth.

The first company to undertake the manufacture of pneumatic tires was the Dunlop Company, organized in Dublin, Ireland, in 1889, with a capital of about $75,000 to make tires for bicycles, and it rapidly grew to be a great business. Then came the automobile to add its demands, and to-day, only 27 years later, the pneumatic tire business of the world is estimated at $650,000,000.

FIG. I. A RAILROAD SCRAP YARD.

A HANDY PNEUMATIC PRESS FOR RAILROAD YARDS

The half tones herewith will serve to illustrate a powerful pneumatic press designed by Mr. E. G. Gross, Columbus, Ga., Master Mechanic of the Central of Georgia Railroad. It is especially designed for railroad work, new work, repair work and for scrapping material.

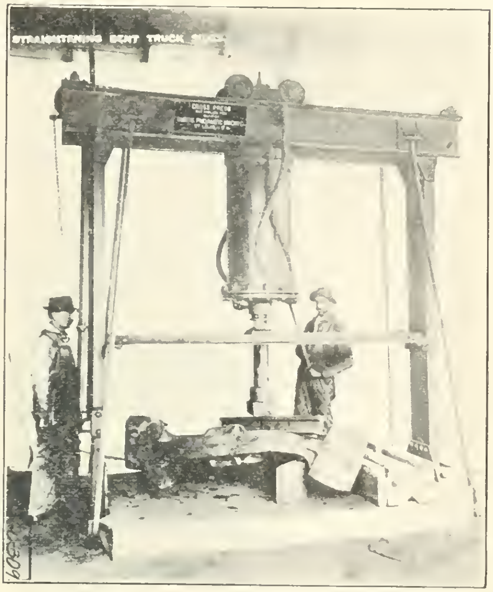


FIG. 3. STRAIGHTENING TRUCK SIDES.

The press, which is intended for permanent installation in shop or yard, consists essentially of a heavy rectangular casting with steel uprights at each end supporting a pair of I beams, with stays to each corner of the base. There is a traveling carriage upon the beams movable longitudinally by a hand chain and suitable gearing. The press cylinder supported by the traveler is thus movable from end to end of the beams.

The cylinder is 19 in. in diameter with a vertical piston travel of 3 ft. and with the usual railroad shop air pressures it is capable of a force of over 100 tons. Suitable air

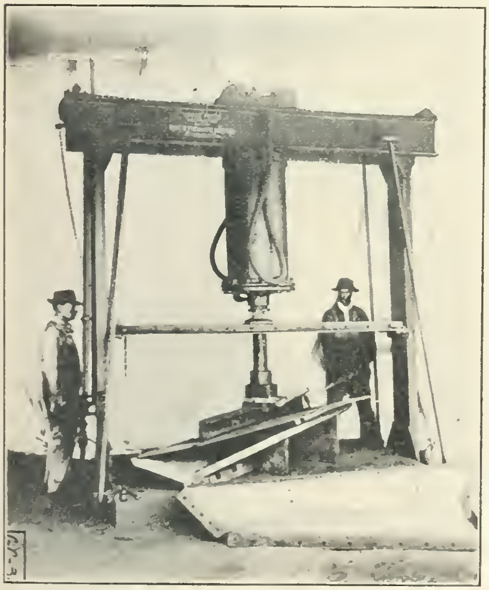


FIG. 2. FORMING HOPPER SHEETS.

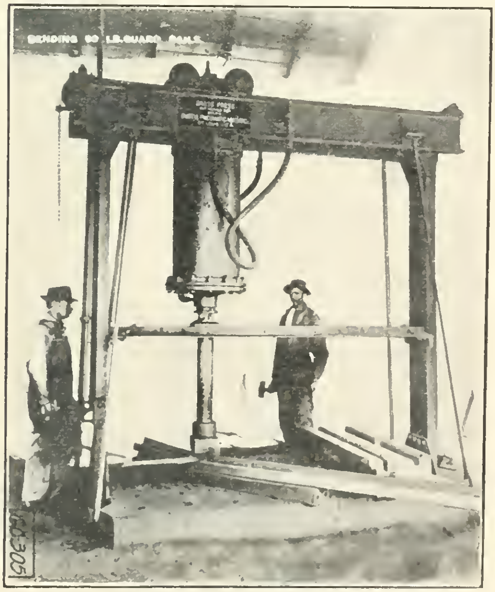


FIG. 4. BENDING ROLLS.

valves control the movement of the piston both downward and upward. On account of the intermittent character of the work the consumption of air is not large.

The press is very simple and does not call for skilled labor to operate it. One of the presses has been in constant service four years without calling for repairs of any kind.

A great number of photos are extant showing the wide range of work to which the press is adapted. It is thought that these here presented will be sufficient.

Fig. 1 shows a railroad yard in which one of these presses is installed, being housed under the shed at the left. Fig. 2 shows the press on new work, forming hopper sheets for steel coal cars. In Fig. 3 the press is on repair work, straightening bent truck sides. Fig. 4 shows the bending of 90 lb. of guard rails.

The press is now on the market, manufactured and sold by Curtis Pneumatic Machinery Company, St. Louis, Mo.

ACTUAL COSTS OF MINE HAULAGE BY HORSES AND BY COMPRESSED AIR

BY RAVUL GREEN.*

The following comparisons only apply to mines working under the following conditions: Seams pitching 25 degs. or more; pit cars containing two or three tons; rails weighing 30 to 40 lb. per yd.; grades fluctuating but little from 0.46 to 1.00 per cent. in favor of the loads; gangways roomy; tracks fairly well kept; curves few and slight.

COMPRESSED AIR HAULAGE.

An average summer month of 1915 was chosen for the test. The output was 33,826 tons, and the number of haulage shifts 19.5. All expense chargeable to haulage, including work done on idle days, holidays, and Sundays, has been allocated to that item. Two hundred 3-ton steel cars were in use, equipped with 18-in. Hadfield wheels. The gangway was laid with 40 lb. rails. Besides the morning haulage shift, an afternoon and a midnight shift were employed. Only sufficient drivers were occupied on the midnight shift to fill all cars in preparation for the day shift, besides handling such supplies and material as are always needed in a coal mine. These extra hands being chargeable to haulage, tend to increase costs, especially if there are many idle days. All locomotives were of the H. K. Porter standard compound type. The haulage comprised two operations: Firstly, the gathering or loading from the mine chutes, and haulage to a main parting—the trips consisting of some 10 to 20 cars, with 6-ton locomotives; secondly, the haulage of 40-car trips, from the main parting to the tipple approach, by the use of 9-ton locomotives.

The monthly expenses amounted to: Track cleaners, drivers, trackmen, etc., $2,335; power house labor, $599; material repairs, cars, boilers, locomotives, $426; coal and other supplies, $1,238; total, $4,598.

In order to obtain an accurate account of depreciation costs, the following items were taken from the equipment ledger: Char. haul., $13,345 (being 50 per cent. prop. of $26,690 cost of boilers, pumps, heaters, and headers); two compressors, $25,000; eight locomotives, $28,300; pipe lines, $12,800; 200 cars, $30,000; boiler and power house at 50 per cent. prop. charg. haul., $5,000; total, $114,445. Depreciation at 11 per cent. per year would equal $1,048 for one month.

Ton miles handled for the month, 70,260.

Cost per ton mile per item: Mine labor, $0.33; power house labor, $0.007; material repairs labor, $0.006; coal and other supplies, $0.017; equipment 11 per cent., $0.015; total, $0.078.

If a full month's run had been realized, that is, if the shipments had reached, say, 41,000 tons instead of 33,000, the theoretical cost would have been $0.060 instead of $0.078. However, it is doubtful if this figure would be reached in practice, as it is based on all the costs decreasing in the same ratio as the tonnage increases, which, in this case, is obviously untrue. For example, the mine labor, the material repairs, and the supplies increase practically in the same ratio as the tonnage. Again, the power house and equipment accounts are more or less fixed in their total, whatever the tonnage. Probably $0.070 would be a very conservative figure to take in such an instance.

HORSE HAULAGE.

The details of conditions under which the test was carried out were: Total tons shipped during the month, 15,573; days haulage worked,

---

*Rocky Mountain Branch. Canadian Mining Institute.

25. The cars were steel framed, wooden boxes, of 2-ton capacity, 18-in. Hadfield wheels; rails, 40 lb. to the yard; tracks in fair condition—no sharp curves; grade quite uniform, averaging 0.5 of 1 per cent. in favor of the loads. An afternoon shift of drivers was employed in order to prepare a full string of loaded cars for the morning shift. Good heavy horses were used. The haulage consisted of two operations: First, hauling from the mine chutes by single horses to a main parting; second, hauling from the main parting to the tipple approach by means of a three-horse spike team, 20 to 25 pit cars composing a trip.

The monthly expenses amounted to: Track cleaners, drivers, helpers, $884; repairs to cars, etc., $164. Supplies and attendance on 22 horses totalled $330. Depreciation charges: For horses this figures as follows, averaging over a period of five years: Total horses owned, 83, value $16,600. Less horses killed, 20, value $4,000; loss on 28 horses sold, $3,560; loss on value of balance, $3,500; total, $11,060. Loss in five years, 66 per cent., or 13 per cent. per year.

Depreciation on horses: 22 horses at $200 each equals $4,400 at 13 per cent. yearly, for one month equals $48. Depreciation on equipment: 130 pit cars at $110 each equals $14,300; stables, stable equipment, tools, $2,966; total, $17,266. Depreciation at 11 per cent. per year equals monthly $167.

The total monthly expenses are therefore as follow: Labor, $1,048; supplies, $330; depreciation horses, $48; depreciation equipment, $167; total, $1,593.

Total ton miles hauled, 14,450.

COMPARISON PER TON MILE.

	Compressed air.	Horses.
Labor	$0.046	$0.072
Supplies	0.017	0.022
Depreciation	0.015	0.015
Total cost	$0.078	$0.109

The conclusions to be deduced from the above facts are that: First, compressed air haulage is about 3c. per ton cheaper than horse haulage; second, cost of supplies and depreciation are about the same in each case; third, compressed air permits of from two to three times as much coal (in certain cases probably more) being handled than by horse haulage; fourth, the main reason for lower cost by compressed air is due to the labor item, in this case about 3c. per ton; fifth, the total of 7⅞c. per ton for compressed air haulage could undoubtedly be reduced to 7c. for a month of 25 working days.

A HANDY DIVING HOOD

To make possible the repair of minor injuries to boat hulls without the necessity of dry-docking, a Florida man, says *Popular Mechanics*, ignoring the reader's right to know who or where, as is custom, has devised a diving hood. This may be placed over the head of a good swimmer, and the man lowered over the side of the boat. Air is pumped down through a hose, and if too high a pressure is attained, the surplus escapes through holes in the hood's lower edge. Wearing a head covering of this sort, the diver can remain under water much longer than without. It is thus possible to make emergency repairs even though far from land and ordinary sources of help. The device has found particular application in tropical waters, where a full diving suit is excessively warm and cumbersome. Sometimes this type of headgear is used by the swimmers as an aid to under-water tussles with sharks, a sport in which some of the more daring delight.

THE SAND BLAST FOR MONUMENTAL LETTERING

The following we take from a circular issued by Foster & Hosler, "Pneumatic Outfitters," 431 S. Dearborn St., Chicago.

HAVE SUFFICIENT AIR.

Do not attempt to install a Sand Blast or New Process, etc., until you know positively whether you have a Pneumatic Plant large enough to operate it. Consult some firm that knows and will tell you honestly and will also inform you what the cost will be of a proper and satisfactory outfit in your shop.

Do not let anybody tell you that a Sand Blast can be operated satisfactorily on 30 cu. ft. of air per minute, as it absolutely cannot be done, and the man who says it can is not practical and does not know what he is talking about. It requires a good medium-sized plant to operate a Sand Blast. It takes from 40 to 50 cu. ft. of air per minute with an ⅛" or 3-16" nozzle on the Sand Blast Hose, which are the general sizes used. It requires a 7½ h. p. motor to run such an Air Compressor for 40 to 50 cu. ft. of air at from 60 to 70 lbs. air pressure. You must have the above air capacity and pressure to get good results from the Sand Blast, and it does not make any difference whose Sand Blast or New Process you install, as they all are the same in air capacity where they use a ⅛" or 3-16" Sand Blast Nozzle for blowing the sand against the work. The air capacity depends on the size of nozzle on hose and also the air pressure used.

SAND BLAST LETTERING

The Sand Blast method of cutting raised letters, and also tracing, is the quickest and best of to-day, and every dealer that has sufficient work for it and can afford to install a Sand Blast Outfit will surely save money on all such work, but he must have the work to get the value out of a plant of that kind. All Sand Blast lettering must be cleaned and finished up with a Pneumatic Tool if you want to turn out good first-class work; therefore, do not let anyone tell you different.

The inscriptions or tracings are all laid out the day before they are blasted. The Sand Blast will cut an ordinary inscription raised ⅛" in from 30 to 40 minutes. It will require from 3 to 4 hours to clean up and finish the above inscription. The traced work does not require any finishing with the Pneumatic Tool, as the Sand Blast will do the work excellently. Sunk letters, square or V shape, are not profitable to cut with Sand Blast as raised letters, hence, the most saving is on raised inscriptions. The heavy raised family name is not so profitable, but the 1-16", ⅛", 3-16" and ¼" raised family names are profitable.

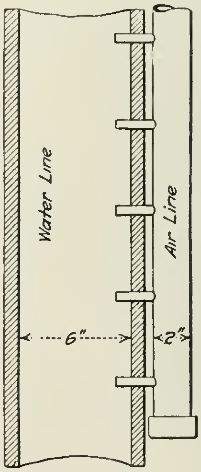
NEEDS SEPARATE ROOM

Every Sand Blast Machine should be used only in a separate room made especially for the purpose with a Blower and Separator, so as to separate the dust from the sand and make it sanitary for the operator. No Sand Blast Machine should ever be used in a workshop or showroom, only in a separate room as above stated.

PUMPING 7,500,000 GALLONS DAILY BY AIR LIFT

The entire water supply (7,500,000 gal. per day) of El Paso, Tex., a city of 100,000 population, is raised from 32 deep wells by an air-lift system, making this probably the largest and most notable installation of its kind in the country. The water-works were taken over by the city from the International Water Co. in 1910 and since then improvements have been made under the supervision of Frank H. Todd, Consulting Engineer for the city.

The wells are 8 to 14 in. in diameter and 500 to 600 ft. deep. They are sunk in a high mesa north of the city, near Fort Bliss. The mesa is a part of the noted Tularosa Valley (the underground water-supply of which is the subject of a recent United States Geological Survey paper). These wells pass through irregular beds of clean but very fine sand with interbedded layers of clay. The latest wells have been driven by the clay-puddling method, in which no drill casing is used. The well casing is standard wrought-iron or steel pipe, with vertical rectangular slots ⅜x10 in., cut out of the sections of pipe that pass through the water-bearing strata. These cuts are made by the water-works employees on the job. The method of placing the air line, shown in the accompanying sketch, is new and was devised by Mr. Todd. The air line is 2 in. and the water line 6 in. in the new 12-in. wells. The air line is 2 in. and the water line 6 in. in the new 12-in. wells. The air inlets are about 214 ft. below the ground surface. The level of the water in the wells has gone down from about 177 ft. in 1905, when the first wells were sunk, to about 200 ft. at the present time. Each (12-in.) well yields about 450 gal. per min.



The air-compressor plant consists of two old steam-driven compressors, one a 750-cu. ft. Ingersoll-Rand and a 2,600-cu. ft. Ingersoll-Sergeant. The new equipment added since the city took over the works includes a 3,600-cu. ft. Allis-Chalmers steam-driven unit and two

2,000-cu. ft. Diesel-engine Nordberg compressor units. The Diesel engines are each 500 h. p., Fulton Toisi engines, built by the Fulton Iron Works, St. Louis, Mo. Each is direct-connected to a 2,000,000-gal triplex pump on one side and a 2,000-cu. ft. air compressor on the other.

Water lifted by the air is delivered by concrete conduits to a centrally located basin where it flows to the pump intakes over a measuring weir. The water supply is then delivered into the city mains by high-pressure pumps.—*Engineering News.*

A JACKHAMER TACKLES AN ODD JOB

BY H. L. HICKS.

The Portland Contracting Company of Pottsville, Pa., in driving a tunnel for the Harleigh-Brookwood Coal Co., at its Stanton Colliery was approaching some old workings. The exact depth at which these would be encountered was not known, and to make sure that they did not contain water it was decided to drill a test hole.

No prospecting drill was available, and as time was of the utmost importance, to avoid the delay of calling in a drilling contractor they determined to try drilling a deep hole with a jackhamer.

The hole was started with four pieces of steel, 3, 6, 9 and 12 ft. long, sharpened to a 2-in. gage. After drilling ahead 12 ft. a bit was welded into a 2-ft. length of 1-in. pipe and a shank into another similar length. With some extra-heavy couplings these were connected to a 10-ft. length of the same size pipe and drilling was resumed.

It was expected that the old workings would be reached at any time after drilling to this depth, but it was necessary to add successive 2-ft. lengths of pipe, resharpening the bit each time, until a 30-ft. steel was being rotated by the little 40-lb. jackhamer.

When the drill ran into the old workings at this depth the drill bit was 1⅝ in. in diameter. The extra-heavy pipe couplings were beginning to bind in the hole, but the operator predicted that he could "go a few feet more if he had to."

This hole was drilled through hard slate formation on about a 6-deg. pitch.—*Engineering Record.*

PNEUMATIC PLACING SAVES SPACE IN CONCRETING RETAINING WALL

BY D. S. STUDDIFORD.

Pneumatic placing was used to advantage in building retaining walls and abutments containing some 30,000 yd. of concrete on the grade-separation work of the Baltimore & Ohio Railroad in Pittsburgh. Ordinary methods might have been employed for concreting the piers and abutments, but the retaining walls were located so close to main-line tracks over which traffic was maintained that lack of space precluded the satisfactory use of such methods.

An electrically driven air compressor was set up on vacant ground just off the right-of-way about midway of the length of the walls. From this plant, which had a capacity of 2,200 cu. ft. of free air per minute, a 6-in. pipe line 2,000 ft. long conveyed air to the mixing plant. The mixer, a ½-yd. Type B machine made by the Pneumatic Placing Company, Inc., was located under a gravel bin of 40 yd. capacity and a sand bin of half this size. Adjoining the bins was the cement house, holding four car loads. The bins were fed by a 20-ton crane. Cement was unloaded into the house direct from railroad cars, and conveyed to the mixer on a track running lengthwise of the house. Two measuring tanks were used, one filling as the other discharged. A perforated pipe circling the top of the mixer insured an even distribution of water and produced a uniform mix for each batch.

Instead of being shot directly into the form, the concrete was conveyed through an 8-in. pipe to a hopper placed on top of the traveler which supported the Blaw wall forms. This was found to be more satisfactory from the standpoint of separating the stone from the grout than to have the pipe discharged into the form direct. Wooden chutes leading to various parts of the form distributed the concrete from the hopper, the flow being controlled by gates. The form sections were 65 ft. in length and 20 ft. high. As the hopper was fastened to the top of the traveler, it moved with the traveler when the form was moved. The only work necessary to resume concreting was to insert extra lengths of pipe in the delivery line.

The quantity of concrete placed varied with the distance of the form from the mixing plant. It was found that at a distance of 400 ft.

about 35 cu. yd. per hour could be placed, while at 900 ft. the quantity fell to between 25 and 30 yd.

Only the actual space for setting up the forms was required by the side of the main-line track, and it was possible to locate both the air plant and the concrete plant where vacant space was available. One setup of the mixing plant, which was constructed so as to be easily taken down and moved, sufficed to concrete 900 ft. each way, or a total stretch of 1,800 ft. P. J. Joyce & Company, Inc., are contractors for the work.—*Engineering Record.*

PREVENTING DUST EXPLOSIONS IN GRAIN SEPARATORS

As a result of a study of explosions in threshing machines the United States Department of Agriculture recommends for the prevention of fires and explosions three measures, as follows:

(1) The installation of an efficient grounding system for the removal of static electricity from the machine; (2) the installation of a suction fan to remove smut and dust and to prevent the formation of an explosive mixture of dust and air while the threshing is being carried on; and (3) the installation of a device to act as an automatic fire extinguisher which in the event of fire will not only save the machine but will prevent the flames from spreading to the surrounding grain.

The first two of these devices have been tried with successful results in the field. The automatic fire extinguisher was not constructed until the threshing season had been closed, but it has been tested under severe conditions in the explosion galleries of the Bureau of Mines at Pittsburgh, and in these tests it has operated successfully. It has also been tested under practical threshing conditions at the government farm at Arlington, and has proved effective in extinguishing fires which were produced in different types of grain separators there. Blue prints of each of these devices may be secured upon application to the office of Public Roads and Rural Engineering of the department at Washington.

The best method, the investigations indicate, for carrying off any static electricity that may be produced is to connect wires from all moving parts on the machine to one wire and to ground that wire. The suction fan is arranged to exhaust from above the cylinder and also from beneath the pan. While it is pointed out that there is no way of absolutely demonstrating that either the grounding of the machine or the suction fan actually prevents explosions, the fact remains that no such occurrences have taken place, so far as is known, with separators that were properly equipped in this way. These devices, however, do not remove all danger from fire, for, in addition to electric sparks, foreign materials which find entrance into the separator may start fires, and for this reason the automatic fire extinguisher is regarded as a desirable additional protection.

A NOVEL SUGGESTION

The man who "rifled" the pipe through which heavy crude oil is pumped solved a difficult problem, for, by mixing a little water with the oil, the centrifugal action produced by the "rifling" keeps the water in contact with the pipe and the oil then does not adhere to the pipe. There are conditions where rotary motion of liquids in pipes is objectionable. For example in pumping water containing granular matter (e. g. hydraulic dredging), rotary motion throws abrading particles against the pipe. *Might it not be wise in such cases to use pipe of rectangular cross-section?*

The above sentence, our italics, comes to us in *Engineering and Contracting.* It suggests great possibilities, but vastly greater impossibilities.

THE BLASTED MOSQUITOES

The following information is official, having been copied from the Year Book for 1916 of the Commissioners of the Borough of Haddonfield, N. J.

"The residents of West Haddonfield were for years pestered and tormented by mosquitoes which it was learned, upon investigation, were propagated in stagnant pools between the railroad and Hadden Ave. It was found practically impossible to drain these to the street gutters hence another method had to be employed and it was decided to sink the water into the ground. Under the supervision of L. Z. Lawrence a heavy charge of dynamite was sunk and discharged about 20 ft. under the surface. This caused the pools to disappear in short order and no water has accumulated at this point up to the end of the year."

COMPRESSED AIR
MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE

Compressed Air Magazine Company
Easton, Pa.

New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. SEPTEMBER, 1916. No. 9

CONTENTS

Some Notes on Belting 8099
Humidity and Belt Tighteners 8102
Portable Mine Hoists in Quarrying 8102
Typical N. Y. Foundation Job 8103
The Business of Mining 8105
Portable Gasoline Air Drill 8106
Cement Gun in Mining Work 8107
Growing Appreciation of Nitrogen 8108
Air Blasts in Mines 8108
Drills for Cracked Rock 8110
Concrete Mixer and Pneumatic Conveyor 8111
Atmospheric Problem in Deepest Mines 8112
Pneumatic Press for Railroad Yards 8115
Mine Haulage by Horses and by Air 8116
Diving Hood 8117
Sand Blast for Monumental Lettering 8117
High Duty Air Lift 8118
Jackhamer Tackles an Odd Job 8119
Pneumatic Placing Saves Space 8119
Preventing Dust Explosions 8120
Future of Aviation 8121
Ventilating Tunnels on the B. & O. 8122
Breaking Bowlders by Block-Holing 8122
What There is in Coal 8122
Hammer Drill Records 8123
Notes 8125
Patents 8127

THE FUTURE OF AVIATION

The art of flying is for the human race a completely established fact. Evermore man may fly as the bird flies, but faster and farther. It is not easy to realize that this achievement belongs entirely to the present century and may be its most epochal event. The development of the aeroplane since the first flight of it has gone along with phenomenal rapidity, and has already been carried so far that it is not possible to predict what its future may be farther than that it is to have a prominent place in human affairs.

Even already it has transformed the art of war and, curiously enough, not by further additions to the traditional military devices. It has added little to the destructive agencies of war, and has not contributed to the art of killing, but it has entirely transformed the science of strategy. There can be henceforth no more surprises and no secret operations except they be subterranean or submarine. Picketing and reconnoissance are done entirely in the sky and done without guesswork. The present raging war could not now be carried on by either side without the aeroplane and the records of exports of these machines from the United States speaks of the foreign demand for them. In 1913 there were 19 machines sent out of the country, in 1914 there were 40 machines, but for 1915 the number is only 2 less than 400.

The latter figure represents a war demand almost exclusively. It may be said that all the builders have been so busy in this line that the use of the aeroplane for strictly peaceful purposes has been for the time ignored. The numbers of machines in use on all the fields of war, of which those of our design and manufacture are only a small fraction, is not the only particular to be noticed. There have been wonderful improvements in all the details and a vast extension of the capacities of the machines. They have been made swifter and more powerful, more controlable, more reliable, safer. The battlefields have been vast testing fields and fields of experiment and suggestion which ultimately must show welcome results in the peaceful skies which we may hope some day to see again.

It may be expected that when the days of war are over—let us hope for a hundred years—the activities of the aeroplane will rapidly increase and extend. It may be at first mostly a plaything for wealth and leisure, as with the automobile, which is daily coming nearer to the lives and uses of all the people. It may be expected also that the aeroplane, with all the possibilities of uncertainty accompanying its flight, will largely assume the function of the race horse, but these, which we may call the preliminary uses of it, will all help to make flying safer, cheaper and adapted to every day uses.

VENTILATING TUNNELS ON THE BALTIMORE & OHIO

Comforts of travel on the St. Louis line of the Baltimore & Ohio Railroad have been increased by an improved system for ventilating tunnels which has been installed in the mountainous district traversed in West Virginia between Clarksburg and Parksburg. A ventilating plant has been completed at Eaton and work of similar character is being rushed as rapidly as possible at West Union. Two others at Silver Run and Ocean will be ventilated during the present season. The ventilating system, involving an expenditure of $70,000 each, drives fresh air ahead of trains and insures comfortable temperature. This is accomplished by means of large revolving fans propelled by steam power plants located near the portals. The water supply necessary for the operation of the plants was secured by digging wells to a depth below the point of pollution. Some time ago the Baltimore & Ohio installed a ventilating system in the westbound bore of Kingwood tunnel. This experiment has proven satisfactory.—*Ry. and Loco. Engineering.*

ECONOMY OF BREAKING BOWLDERS BY BLOCK-HOLING

The Bureau of Mines conducted an investigation to determine the comparative efficiency of the block-hole and the adobe methods of breaking large bowlders. The results were reported in Technical Paper No. 17 of the Bureau.

Large blocks of limestone of uniform texture were rough-cut into cubes of approximately the same size, and charges (two cartridges, each measuring 1⅛ by 8 inches) of 35 per cent. dynamite were fired on the blocks without and with a mud capping. A charge without capping produced no effect other than a slight crack in the block, but an equal charge of dynamite partly confined by a mud capping broke a similar cube into many small pieces. Test of the block-hole method on a similar limestone cube, a 1-inch hole being drilled 12 inches deep in the center of a face of the cube, showed that 1 ounce of dynamite produced as effective results, if this charge was confined by stemming firmly tamped to the top of the hole, as did an unconfined charge of about 1 pound of the same explosive fired upon the block.

Block-holing, of course, involves a higher labor cost than mud-capping, but progressive quarrymen and miners have long since learned that by using the fast drilling Jackhamer for drilling the block-holes the extra expense of drilling is practically negligible when compared with the big saving made in the cost of explosive.

WHAT THERE IS IN COAL

BY C. G. ATWATER.

If there be any one who doubts that great natural law of the indestructibility of matter, certainly consideration of coal and its by-products should convince him. We do not know how hot the sun was in the forests of the Coal Age; we do not know whether continuous thunder storms helped in nitrogen fixation; we do not know the color of the tropical vegetation, the odor of its blossoms, nor the taste of its fruits; whether they were poisonous or healthful, whether they grew slowly year by year or shot up over night as in fairy tales; but we do know that, buried deep in the earth, lost forever according to human standards, through centuries, we receive again the sun's heat and light and through the glowing furnace and in response to the chemist's skill we again see those colors, smell the odors, and grow sick or recover from the drugs. We may even taste those flavors and eat the fruits, or if not exactly them, at least some synthetic product so much like them that the ordinary man cannot tell the difference.—*Engineers' Society of Western Pa.*

HAMMER DRILL RECORDS AT THE FRANKLIN MINES, NEW JERSEY.*

The compressed-air rock drill made revolutionary changes in mining methods and in the reduction of mining costs in units of labor per ton of ore, and at Franklin even more marked savings have been made through the development of hammer drills. There, in the days of hand drilling, a total of 8 ft. in three drill holes with varying diameters of 1¾ to 1¼ in. was considered a fair 10-hour shift's work, and possibly 8 tons of ore would be broken per drill-shift or 4 tons per man-shift. With 3-in. reciprocating rock drills from 20 to 40 ft. of drill holes, ranging in diameter from 2½ to 1½ in., would be the average work for a 10-hour shift, although on rare occasions some men might drill as much as 80 or 90 ft. of holes in a shift, and possibly 20 tons of ore would be broken per shift, or 10 tons per man-shift, since two men were needed on a drill. It seems that as a rule a greater tonnage per foot of hole was obtained with hand drilling because of the fact that, rather than dismount and reset heavy drill columns, machine men would tend to place as many holes as possible from one set-up, therefore many holes were placed disadvantageously for breaking efficiency. Another cause, which would contribute to the same results, would be the difficulty of starting holes with piston drills on uneven sloping faces, so that holes were frequently deflected from the direction in which they were supposed to be placed. These figures would lead to the rough estimate that 2½ times as much tonnage per drilling man-shift was accomplished by piston drills as by hand drilling.

With hammer drills 80 to 100 ft. of 1¾ to 1¼-in. drill holes are placed by one man in a 10-hour shift, about 150 to 200 tons of ore will be broken per drill-shift and the same amount per drilling man-shift, or 15 to 20 times the amount broken per man with reciprocating drills. Of course, the entire credit for such increase in tonnage cannot be given to the type of drill, for improved organization, system of working, and supervision have undoubtedly played an important part; but the greater mobility and flexibility of the light hammer drills have permitted and encouraged a more efficient placing of drill holes; have cut in half the labor necessary to run a drill; and permitted a more effective supervision and mining scheme.

DRIFTING.

There have been no radical changes in the placing of the drill holes in drifts since the adoption of the air-feed hammer drill for this work, but one man with a single machine is now placed in a heading; he is instructed to "pull" a "round" each 8-hour shift, stopping overtime if necessary, and to accomplish an advance of 3½ to 4 ft. per round. Two men operating a reciprocating rock drill formerly made an advance of a 5 to 6-ft. round in five 10-hour shifts. So the drilling labor (runners and helpers) per foot of advance averages 18.4 hours for the entire mine during the year 1910, when reciprocating rock drills were solely in use. As shown by the average for 1913, hammer drills reduced this figure to 5.3 hours per foot of advance, or about one-third the former labor of drilling and blasting. The explosive costs have also been reduced by the use of hammer drills from the figure of $1.84 per foot of drift during 1910 to $1.40 per foot in 1913, for two probable reasons.

First, hammer drills permit the placing of drill holes smaller in diameter than those bored by reciprocating drills, so that an unnecessary amount of explosive is not required merely to fill the holes sufficiently to distribute the force of the explosion.

Second, the flexibility and ease of rigging the light hammer drills permit and encourage a more efficient placing of drill holes. The almost exclusive use of 1 by 8-in. explosive cartridges now, as contrasted with the 1⅛ by 8-in. cartridges formerly used, demonstrates the first contention, for in terms of 1-in. powder, the equivalent of 36.8 sticks per foot of drift was used in 1910, and 34.6 sticks per foot in 1913. The drill shifts per foot of advance have been lowered from 0.74 in 1910 to 0.33 in 1913, and the corresponding drill hours from 7.4 to 3.0.

The different drifts may vary in size from 6 by 7 ft. to 8 by 11 ft. in section, and perhaps 7 by 8 ft. is an average section. Because of the compact, tough nature of the ground, it requires from 20 to 30 drill holes in a round, and 24 would be a fair average, so the drilling operation is an important factor of the drifting costs. The following comparison of the average drifting costs for each year shows the saving which has been possible because of hammer drills; but only the cost of drilling labor and explosives is considered. The record drift in 1913 was driven for $2.06 per foot.

---

*From a paper before the American Institute of Mining Engineers, by B. F. Tillson, Franklin Furnace, N. J.

	1910.	1911.	1912.	1913.
Drifting cost per foot	$5.33	$4.92	$3.35	$2.70

RAISING.

In 1908, using 2¼-in. piston reciprocating rock drills, 0.7 ft. of 6 by 6 ft. raise per 10-hour drill shift was made with a labor expense of 28.5 man-hours per foot of raise. About 27 ft. of drill holes were placed per shift, 24 holes were placed in a round, and 16 lb. of explosives were used per foot of raise advance, at a cost of $2.70 per foot for supplies. Since labor was then paid $2 and $1.55 per 10-hour shift, the total cost of raising was approximately $7.50 per foot of advance.

During the same year, 1908, hammer drills were introduced, and an advance of about 1.5 ft. per drill-shift was made with a labor expense of 13.3 man-hours per foot of advance. About 50 ft. of drill holes were placed per shift, 24 holes per 5-ft. round, and 10 lb. of explosives were used per foot of advance, at a cost of $1.75 per foot for supplies and a total cost of $4.10 per foot of raise, or only 55 per cent. of the cost with the reciprocating rock drills.

The development of hammer drills with increased drilling speed permitted the reduction of the drilling labor to 7.8 hours per foot of raise advance, and the explosives cost to $1.54 per foot of raising done in the year 1910; and a further reduction of 4.8 hours of drilling labor during 1912, and an explosive cost of $0.93 per foot, although the wages were $2.20 and $1.70 per 10-hour shift. These costs rose slightly in 1913, since wages rose to $2.25 and $1.85 for 10-hour shifts, and in July of the same year the working hours were lessened from 10 to 8 and the hourly wage was increased to $0.281 and $0.231. However, the cost per foot was then only 5.2 hours of drilling labor and $1.03 per foot for explosives. About 18 drill holes are now placed to pull a 5-ft. round and two men are expected to blast a round each 8-hour shift and are each paid 11 hours' time for performing the task.

The average raising costs for operating labor and explosives have been as follows:

	1910.	1911.	1912.	1913.
Raising cost per foot	$2.95	$2.31	$1.88	$2.22

The record short raise (of about 50 ft. in length) for 1913 had a cost of $1.65 per foot, and the record long raise (about 100 ft. long) had a cost of $2.09 per foot, with explosive costs, respectively, of $0.77 and $0.99 per foot of raise.

STOPING.

In 1909, when about 74 per cent. of those drills placing holes in the solid ore body were of the reciprocating type of 3-in. piston diameter, the ore production averaged about 20 net tons of ore broken from the solid per 10-hour drill shift, with an equivalent of 1.1 sticks of 1 by 8 in. of 50 per cent. dynamite per ton of ore.

In 1910, when about 72 per cent. of the producing drills were air-feed stoping (hammer) drills, the tonnage per drill shift rose to 38 net tons with about the same amount of explosives (which cost $0.055 per net ton of ore broken), and 13.2 tons were broken per 10-hour shift of men working in stopes, or 1.32 tons per hour. Although there is no record of the breaking labor prior to this year, the fact remains that in the actual running of the drills only one man was used with a hammer drill while two men were employed with each reciprocating drill.

In 1911, when the hammer drills were about 80 per cent. of the total, the stoping efficiency profited by the improvements in the drilling speed of the hammer drills, and 121 net tons were broken from the solid per drill-shift with about 0.8 stick of 50 per cent. 1 by 8 in. dynamite per ton (at an explosive cost of $0.041 per ton), and 2.03 net tons were broken per man-hour of men working in stopes.

In 1912, when about 98 per cent. of the stoping drills were hammer drills, 195 net tons were broken per drill-shift with about 0.87 stick of 50 per cent. 1 by 8 in. dynamite per ton (at an explosive cost of $0.045 per ton, and at the rate of 2.56 net tons per man-hour in the stopes.

In 1913, when all the stoping drills were hammer drills, the length of the working shift was reduced from 10 to 8 hr. in the middle of the year and the tonnage broken per drill-shift fell proportionately to 170 net tons, but remained at approximately the same hourly rating as for the year 1912. However, the tonnage broken per man-shift in the stopes increased slightly to 26.7 net tons at an explosive cost of $0.049 per ton, with the consumption of 0.89 stick of 50 per cent. 1 by 8 in. dynamite per ton. The tonnage broken per man-hour was 2.97, which showed a steady gain over previous years.

It should be noted that the explosives charged against stoping include those used by the trammers in blasting ore in the chutes, and thus represent all the dynamite necessary to reduce the ore to the proper size for being handled through chutes and in the mill.

OPENCUT.

In order to provide broken rock for filling material to fill empty stopes to support the remaining ore-body, "mill-holes" are developed in limestone country rock at the surface. For some years it was the practice to use 30-ft. bench-holes in the opencut for quarrying the rock, both 3-in. and 3½-in. reciprocating rock drills being used. It took steady work for two men to sink one 30-ft. hole in a 10-hour shift, and their work was hazardous because of the inconvenient localities where set-ups were made, and because of the clumsy weight of their machines and the long, heavy drill steels which were handled. After the success of hammer drills in the underground mining operations, they were tried in the opencut work in 1912. Small holes were drilled to an average depth of 16 ft., and were given lighter burdens than had previously been the practice, for the object was to distribute the dynamite more evently in the rock, as contrasted to churn-drill or mammoth blasts. In the tough, crystalline Franklin limestone this application of hammer drills to quarrying has proved superior to the heavy or mammoth blasts, for the same tonnage can be produced from a bench with a saving of labor and powder, since a great amount of expensive block-holing is avoided. A machine will drill about 100 ft. of holes in a shift with a heavy hammer drill and two men can drill only 30 ft. with a rock drill.

SELF PUMPING WELLS

Along the lower courses of the Potomac and Rappahannock and along the shores of the many inlets that run back from Chesapeake Bay above the James there are hundreds of artesian wells that supply a perennial flow of beautifully clear water which is, as a rule, excellently adapted to all domestic uses and is largely utilized by the canning factories and other industrial establishments that abound in that part of the country. Though the pressure of the water from the wells is ample at the shore level, the head diminishes so quickly with increase in elevation that no flow can be obtained along the higher banks above the shores where the water is most needed. One method of obtaining it at these higher levels is to use the force developed by the artesian flow to operate hydraulic rams, which in turn raise the water to the heights desired along the bluffs above the river and inlets. Thus it may be said that the artesian wells pump themselves.

NOTES

The Bureau of Standards, Department of Commerce, in connection with a general study of fire-resisting materials, is considering among other phases of the subject the development of a fire-resisting material for use in constructing, in whole or part, the deck structures of excursion and passenger steamers. So far as may be applicable, the material when developed would also be considered in relation with other marine uses. The Bureau of Standards would be glad to receive from manufacturers samples of such materials as they consider suitable for the purpose, in order that they may be given consideration.

For waterproofing the upstream face of the Elephant Butter dam the cement gun was employed. The apparatus was mounted on a wooden raft and a mixture of cement, sand and water was shot against the face of the dam. The coating was applied in horizontal strips about ten feet high and the length of the dam at water level. The mortar waterproofing coating was applied in four layers, each about a quarter of an inch thick. Numerous samples taken from the face of the dam showed perfect adhesion of the waterproofing coat to the original concrete.

A series of experiments recently carried out by the British Fire Prevention Committee shows that the best way to extinguish a small gasoline fire is to spread over the burning liquid a mixture of 10 pounds of bicarbonate of soda and 12 pounds of common sawdust. The sawdust need not be wet, but must be free from chips and shavings. The theory is that the sawdust, by floating on the burning liquid, excludes the oxygen of the air, and the heat of the flame generates carbonic acid gas, which helps extinguish the fire. Sawdust alone gives satisfactory results, indeed better than sand or similar materials.

The belief that the stars may be seen in daylight from the bottom of a deep well, shaft or tall chimney is a very old one. Its wide currency is perhaps due to the fact that it is found in the works of Aristotle, whose authority was regarded as final on all subjects for so many centuries. One of the first scientific men to investigate the correctness of this idea was Humboldt, who spent a great deal of time in mines himself, and also questioned miners in various parts of the world, without finding the slightest evidence that the stars are ever visible by day from the bottom of mine-shafts.

For the use of pneumatic tubes for the transmission of mail in the large cities, which has been a subject of a good deal of controversy in Congress, the Post Office appropriation bill for the current year allows $976,000; but it authorizes the continuation of the present contracts only until March 4, 1917; the understanding being that the question will be reopened in Congress before that date.

When a very high vacuum is desired finely divided copper, such as is obtained by reducing a solution of a copper salt, and commercially known as "precipitated copper," may be used with advantage to absorb the last traces of gases, which it takes up rapidly. When used for this purpose a few grammes of the copper are placed in a bulb which is sealed to the vessel to be exhausted, and while the copper is heated to about 250 degrees, to free it of any gases it may be holding, an air pump is operated to effect a partial vacuum. The pump is then disconnected, and as the copper cools it rapidly absorbs the remaining gases. This absorption is not a chemical action, as the gases are again liberated when the copper is heated.

The West Clare Railway of Ireland, one of the so-called "Irish light railways" (narrow-gage), runs from Ennis to Kilkee. For 36 miles it follows the Atlantic seaboard, exposed to the full fury of the westerly gales. Derailment of trains in heavy gales has occurred several times. Shelter banks, thrown up on the windward side of the railway, were ineffective and expensive. Finally the Meterological Office was consulted by the chief engineer of the railroad, and a pressure tube anemometer was installed to give warning of winds of dangerous veloctiy by ringing a bell in the station-master's house. Two warnings are given, the first when the instrument indicates 65 miles an hour and the second when the velocity rises to 85 miles an hour. When the first warning has been given, 24 hundredweight of movable ballast, kept for the purpose at every station, are put on each car of the train, this being amply sufficient to prevent an overturn. If the second warning comes, the trains are stopped until the storm abates. The anemometer was installed in December, 1909, and has never failed to give the proper warning.

The adoption of the metric system in India, said Alfred Chatterton, Director of Industries and Commerce, in a paper presented to the Indian Industrial Conference at Bombay, noted in *The Engineer,* February 4, 1916, would complicate all its dealings with the rest of the British Empire. It may perhaps be thought that if India led the way, the British Empire would follow; but there is no possibility of the English-speaking races adopting the metric system. That is a dream of visionary enthusiasts. We have accepted the metric system for use in our laboratories, and that is as far as we intend to go. The idea, therefore, of India adopting the metric system does not come within the range of practical politics. In the future we are going to strengthen the ties that unite the various parts of the British Empire, and we may take it as certain that if there is to be any reform in regard to weights and measures in India, it will be in the direction of bringing them into line with the rest of the Empire.

The government egg car has recently been touring Indiana. With this car the United States Department of Agriculture educates the farmers in egg candling, packing and chilling. The demonstration car is in itself a complete refrigerating plant on wheels, with its own gasoline engine for operating the refrigerating blowers, which in the course of half an hour can lower the temperature of the cold room to 32 degrees. By the aid of models, shippers and railroad men are shown methods of stowing cases in cars so as to minimize damage in transit.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JULY 4

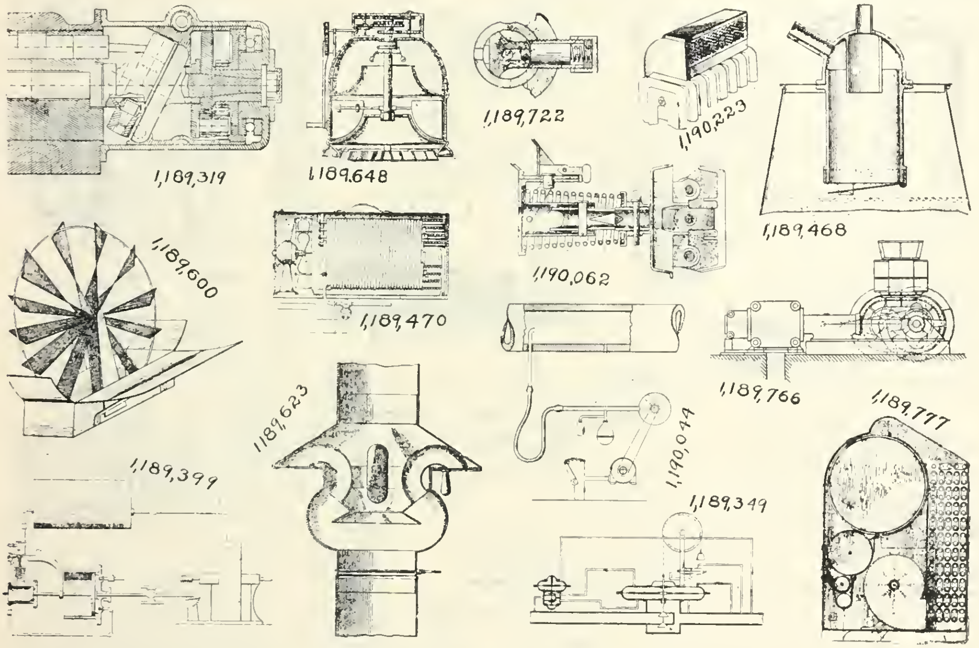
1,189,319. FLUID-PRESSURE APPARATUS. CHARLES LESLIE WALKER, London, England.

1,189,349. PRESSURE - REGULATOR FOR GAS SYSTEMS. FRANK L. CROSS, Detroit, Mich.

1,189,399. MOTOR. GEORGE E. SKAGGS, St. Louis, Mo.

1,189,468. MILKING-MACHINE. REUBEN MANLEY MILLER, Dayton, Ohio.

1,189,470. AIR COOLER AND DEHUMIDIFIER. GLEN O'BRIEN, Manhattan, Kans.



PNEUMATIC PATENTS JULY 4.

If it is dangerous to allow quack physicians to practice, as witness the stringent medical regulations now in force everywhere, is it not time that more restrictions be placed on the activities of amateur electricians? We read of a case in which, while a man was having his tub, a 200-volt electric lamp fell into the bath, electrified the water and killed the man. The lamp had been fixed up by his brother, an unprofessional; and at the inquest the coroner remarked that there did not appear to be any regulations to prevent people making unauthorized connections to electric fittings.—*Indian Engineering.*

1,189,600. HUMIDIFIER AND DISINFECTOR. RAYMOND A. MALLETT and CHARLES MCCLUNG, Sacramento, Cal.

1,189,623. SMOKE-PIPE AIR-CHECK. HULDRICK B. REID, Washington, D. C.

1,189,648. VACUUM CLEANING DEVICE. WALTER ANDERSON, Fairmont, Okla.

1,189,680. AIRSHIP. JEFFERSON M. GARDNER, New London, Conn.

1,189,711. APPARATUS FOR SEPARATING VAPORIZED VOLATILE LIQUIDS FROM GASEOUS MIXTURES. WALTER E. LUMMUS, Lynn, Mass.

1. An apparatus for separating vaporized volatile liquids from gaseous mixtures having, in combination, means for compressing the gas-vapor mixture, means for cooling the compressed gas-vapor mixture to condense the vapors, and means for washing the cooled compressed gas-vapor mixture, substantially as described.

1,189,722. AIR-COMPRESSOR. JOHN P. MURPHY, Charleston, S. C.

1,189,766. IMPELLER PUMP OR BLOWER AND DRIVER THEREFOR. JOHN T. WILKIN, Connersville, Ind.

1,189,777. DRYING APPARATUS. WILLIAM BARTHOLOMEW, Chicago, Ill.

1. In a drying tumbler, the combination with a casing, of a rotary cylinder in said casing for containing articles to be dried, a heating chamber, a blower for circulating air through the heating chamber and thence through the cylinder, a screen through which the air passes before being drawn through the blower, and means for automatically removing the particles of material deposited upon said screen.

1,189,811. MEANS FOR PRODUCING BOTTLES. JOSEPH B. GRAHAM and FRANK R. MILLER, Loogootee, Ind.

1. In a glass working machine the combination of a rotary mold-carrying table, a body mold mounted thereon and comprising mating members movable relative to each other, a neck forming plunger movably mounted in the table and provided with an air duct and port, an air passage formed in the body of the table and having one end arranged for registry with the port of the plunger air passage, and means for supplying air to the air passage in the table.

1,190,044. MEASUREMENT OF SMALL PRESSURES. ELIHU THOMSON, Swampscott, Mass.

1. The method of measuring small fluid pressures, which consists in admitting said pressure to a transparent chamber, introducing a visible gas, setting up in said chamber a counter-pressure sufficient to check the movement of said visible gas and measuring the energy required to produce said counter-pressure.

1,190,062-3. FLUID-PRESSURE COUPLING. LEONIDAS D. WOODRUFF, Newport, Ky.

1,190,173. AUTOMATIC TRAIN - STOPPING AND RECORDING DEVICE. FREDERICK F. HUDSON, Memphis, Tenn.

1,190,223. HUMIDIFIER. URIAH DAVIS, Park Ridge, Ill.

JULY 11

1,190,267. METHOD OF PRODUCING HYDROCARBON FROM HYDROCARBON-BEARING EARTH-STRATA. IRWIN L. DUNN, Long Beach, Cal.

A method of obtaining the lighter liquid hydrocarbons from the earth which consists in forcing atmospheric air into hydrocarbon bearing strata thereby carbureting the same, drawing off the carbureted air so produced, and condensing the hydrocarbons from said air to a liquid form.

1,190,268. METHOD FOR INCREASING THE PRODUCTION OF OIL-WELLS. IRWIN L. DUNN, Marietta, Ohio.

1. A process for increasing the production of oil wells consisting in forcing a gas into one of the wells of a group under pressure, exhausting gas from other wells and pumping oil from the latter.

1,190,294. MILKING-MACHINE. GUSTAF EMIL JONSSON, Halmstad, Sweden.

1,190,342. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Wilkinsburg, Pa.

1,190,376. SAFETY APPLIANCE FOR AEROPLANES. FRED J. CHIONE, La Salle, Ill.

The combination with an aeroplane, of a normally-deflated balloon connected to the top of the aeroplane at the center thereof, a tank for compressed gas connected with and pendent from the aeroplane, a conduit intermediate said tank and the interior of the balloon and extending within the balloon, a controlling valve in said conduit, a downwardly-seating non-return valve arranged in the portion of the conduit within the balloon, an escape valve carried by the balloon, means for opening said valve connected with and pendent from the same, and an auxiliary tank for compressed gas connected through a valved conduit with and pendent from the first-named conduit.

1,190,386. AIR - CONDITIONER. MALCOLM DICKERSON, Newark, N. J.

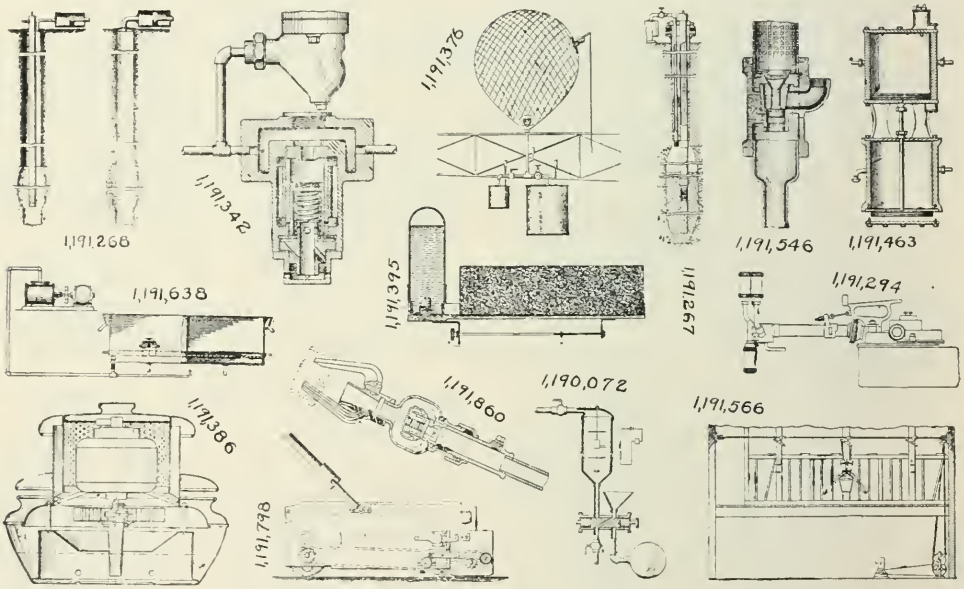
1,190,387. ROCK-DRILL. ANDREW L. ENGELS, and JOSEPH WALKER, Bisbee, Ariz.

1,190,388. HOT-AIR BATH. WILLIAM F. ERATH, Rosebank, N. Y.

1,190,395. AIR-MOISTENING DEVICE. EDGAR L. FLORY and BENJAMIN M. OSBUN, Chicago, Ill.

1,190,463. AIR-COMPRESSOR PUMP. BERNARD M. ROGGENBUCK, Norfolk, Va.

1,190,546. PNEUMATIC PUMP. JOSEPH S. HATTERY, Waterloo, Iowa.



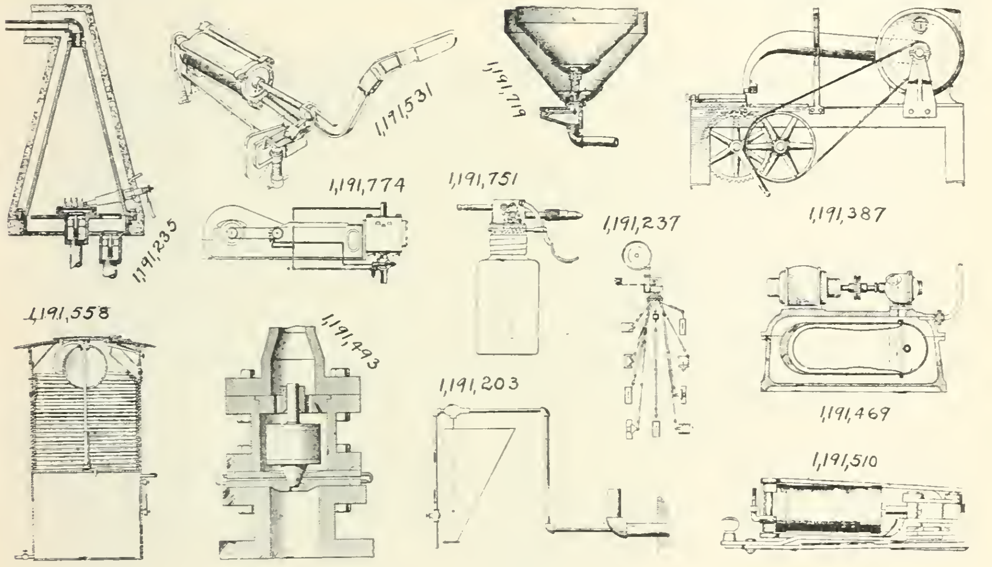
PNEUMATIC PATENTS JULY 11.

1. A sprayer-device, for air-lift pumps, comprising an orificed conduit, a chamber in communication therewith and with a supply of air under pressure, and an inverted cone supported within said chamber, spaced from its inner walls and extending toward said conduit coaxially within the path of upward movement of air into the conduit, to deflect the air toward the inner wall of the conduit.

1,190,566. SUCTION MILKING - MACHINE. KENNETH K. MCLEOD, St. Paul, Minn.

1,190,638. APPARATUS FOR TREATING FOOD STUFFS AND THE LIKE. GEORGE B. FURMAN, East Orange, N. J.

1. An apparatus for treating food stuffs comprising a container for a liquid in which said food stuffs are immersed, a removable air compression chamber in said container comprising a continuous and endless side wall and a transverse wall connected with said continuous and endless side wall throughout, said compression chamber being provided with perforations whereby air is distributed to said liquid and means for introducing air into said compression chamber.



PNEUMATIC PATENTS JULY 18.

1,190,639. AUTOMATIC AIR-HOSE COUPLING. PHILIAS A. GAGNON, Bathurst, New Brunswick, Canada.

1,190,691. METHOD OF PACKAGING AND PRESERVING TEA. WILLIAM G. VOLKMANN, Oakland, Cal.

1. The method of packaging and preserving tea, the same consisting in first heating the tea to drive the moisture therefrom, thence placing the same in a package for the hermetic sealing thereof, thence exhausting the air from within the package, and finally hermetically sealing the package before the tea is permitted to cool to an appreciable extent.

1,190,767. PNEUMATIC ADJUSTING MECHANISM FOR MUSICAL INSTRUMENTS. VERN L. JONES, Detroit, Mich.

1,190,798. PNEUMATIC CARPET-SWEEPER. FRANK J. QUIST, Worcester, Mass.

1,190,804. AIR-PUMP ATTACHMENT FOR AUTOMOBILE. ARTHUR J. SCAIFE, Cleveland, Ohio.

1,190,860. DEVICE FOR DELIVERING GASEOUS FLUID UNDER PRESSURE. CHARLES A. CLAFLIN, Medford, Mass.

1,190,893. PNEUMATICALLY - OPERATED PIANO. GUSTAV KARL HENNIG, Bohlitz-Ehrenberg, near Leipzig, Germany.

1,191,072. METHOD FOR UTILIZING PULVERULENT MATTER AS FUEL. REGINALD A. FESSENDEN, Brookline, Mass.

1. The method of producing a mixture of pulverulent matter and gas, which consists in introducing, in a definite and predetermined ratio of matter to gas, the matter into a chamber containing compressed gas, maintaining the matter in said chamber in a state of suspension and in an unburned condition.

JULY 18

1,191,187. AIR-BRAKE APPARATUS. OSCAR JOHNSON, Chicago, Ill.

1,191,195. APPARATUS FOR THE PRODUCTION AND UTILIZATION OF WORKING FLUIDS. OTTO KRAUS, New York, N. Y.

1. An apparatus of the character described, including a furnace; an air-compressor; a compressed-air reservoir supplied by the latter; a conduit which connects said air-compressor and furnace; a second conduit which connects the first-named conduit with said reservoir; and a valve which automatically prevents the backflow of air from said reservoir to said air-compressor through said conduits, while permitting the free flow of air from said air-compressor to said furnace through the first-named conduit.

1,191,203. APPARATUS FOR FEEDING FINELY-DIVIDED FUEL. CHARLES LONGENECKER, Springfield, Mass.

1,191,225. PULVERIZED - FUEL BURNER. WIRT S. QUIGLEY, New York, N. Y.

1,191,226. ADJUSTABLE AIR-BLAST APPARATUS. WIRT S. QUIGLEY, New York, N. Y.

1,191,235. FLUID-PRESSURE GENERATOR. ERNST RICHTER, Cincinnati, Ohio.

1,191,237. SUCTION APPARATUS. MORITZ ROSENTHAL, Vienna, Austria-Hungary.

1,191,387. VACUUM CHALK - ERASER CLEANER. OTTO C. BAUMGART, Atascadero, Cal.

1,191,469. DEVICE FOR THE PREVENTION OF AIR-LOSSES IN LIQUID-CONTAINERS UNDER AIR-PRESSURE. CARL JOHAN RIXEN, Aeroskobing, Denmark.

1,191,493. APPARATUS FOR ELEVATING LIQUIDS. George F. Bihn and Albert Jones, Philadelphia, Pa.

1. In an apparatus for elevating liquids the combination of a vessel having an inlet and an outlet for the said liquid; a valve comprising an outlet port for the air displaced in the said vessel, and oppositely disposed ports for compressed air; a float adapted to be operated by the liquid in the said vessel for controlling the said ports, and having means extending between said inlet ports for compressed air, substantially as set forth.

1,191,510. TIRE-PUMP. George I. Hipple, Chicago, Ill.

1,191,531. TIRE-PUMP. Johan Ludvig Nilson, Chicago, Ill.

1,191,558. APPARATUS FOR RAISING SUNKEN VESSELS. Robert W. Bryant and Alfred E. Moore, Pueblo, Colo.

1,192,354. AIR-CUSHION CONTROL. Burt D. Stevens, Evanston, Ill.

1,192,370. VACUUM FEED DEVICE FOR INTERNAL-COMBUSTION ENGINES. Friedrich W. Baumgaertner, Cleveland, Ohio.

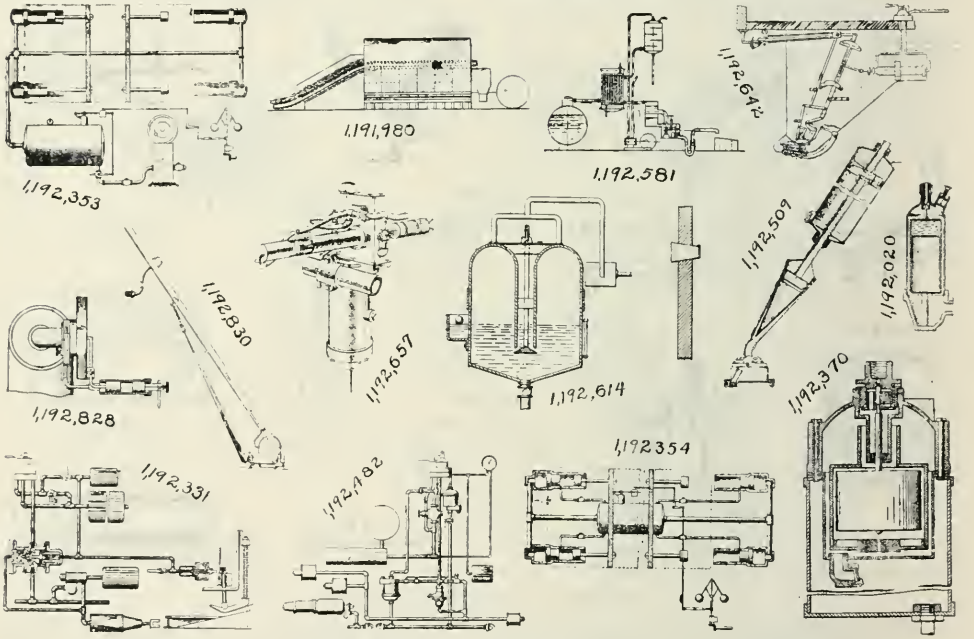
1,192,482. AIR - BRAKE SYSTEM. Peter Wertz, Pittsburgh, Pa.

1,192,509. PNEUMATIC-CLEANER PUMPING MECHANISM. Edmund J. Feeny, Munice, Ind.

1,192,581. APPARATUS FOR DISTILLING PETROLEUM, TAR OR OTHER SUBSTANCES UNDER VACUUM. Leo Steinschneider, Brunn, Austria-Hungary.

1,192,614. STORAGE AUTOMATIC RAREFIER. John C. Fleming, Boston, Mass.

1,192,642. PNEUMATIC MECHANISM FOR OPERATING AN EXTENSIBLE CAR-STEP. Hiram D. Kirkley, Paragould, Ark.



Pneumatic Patents July 25.

1,191,719. SAND-BLAST. William P. Mott, Chicago, Ill.

1,191,751. AIR - BRUSH. Liberty Walkup, Rockford, Ill.

1,191,774. REGULATOR FOR COMPRESSORS. Richard W. Douglass, White Plains, N. Y.

JULY 25

1,191,980. APPARATUS FOR CURING FRESHLY-CUT CROPS. Arthur J. Mason, Chicago, Ill.

1. In an apparatus for curing freshly made crops, the combination of a conveyer, a furnace having a smoke flue discharging beneath said conveyer, and means for supplying air under pressure to, and directing the same upwardly within, said flue.

1,192,009. PLAYER-PNEUMATIC. Charles H. Spencer, Baltimore, Md.

1,192,020. AIR-VALVE. Frederick H. Tweed, Chicago, Ill.

1,192,331. APPARATUS FOR THE CONTROL OF FLUID-PRESSURE BRAKES. Lloyd V. Lewis, Edgewood Borough, Pa.

1,192,353-4. AIR-CUSHION CONTROL FOR PRINTING-PRESSES. Burt D. Stevens, Riverside, Ill.

1,192,657. DRILL-OPERATING MECHANISM. Joseph D. MacDonald, Butte, Mont.

1. In an apparatus of the character specified, the combination of a drill-bar; a pneumatic hammer carried thereby; an oscillating clamp for supporting said bar; an air-line leading to the hammer; a pump adapted to force water into said air-line; and a motor for actuating the pump and oscillating the clamp.

1,192,702. PNEUMATIC SPEED AND DISTANCE INDICATOR. Eugen Steiger, Zurich, Switzerland.

1,192,828. DEVICE FOR REPRODUCING SOUND. William H. Crawford, Providence, R. I.

1. In a talking machine and the like, a device for reproducing sound having means for transmitting the original vibrations comprising a cylinder, two pistons in the cylinder leaving a space between them wherein air is confined, a rod on one piston connecting with the sound box, a support on the other piston, and a stylus in the said support.

1,192,830. SUCTION-CLEANER. James B. Kirby, Cleveland, Ohio.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XXI OCTOBER, 1916 No. 10

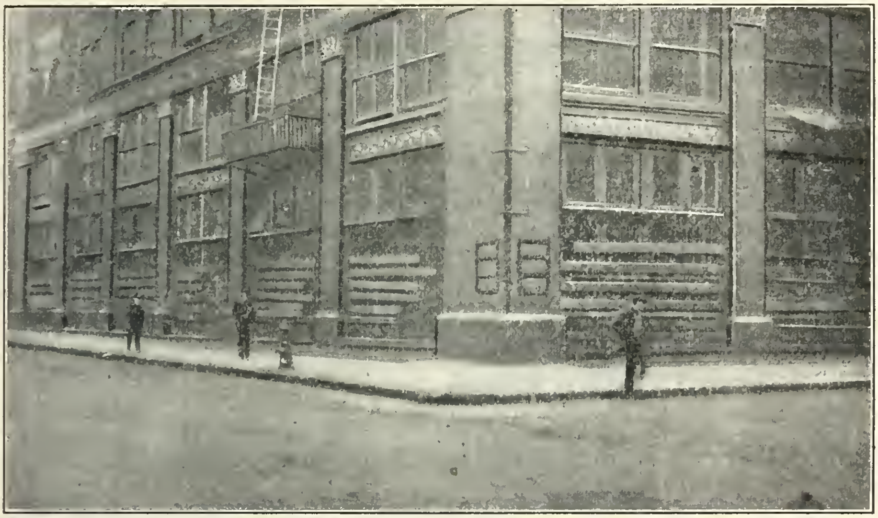


FIG. I. ALL THE BIG WINDOWS BROKEN.

HOW THE WINDOWS WERE BROKEN

BY FRANK RICHARDS.

An unusual sensation, even for New York City, was caused by the explosion of munitions in the harbor on July 30th. The sensation would have been much greater if the explosion had not occurred in the sleepiest hour of the night so that there were comparatively few who heard it. The visible effects, however, were widely distributed all over lower Manhattan and even as far uptown as the nineties. There was apparently only very slight damage done anywhere except in the breaking of glass, but for that item alone the estimate of one million dollars loss is quite generally accepted.

As there were few missiles flying there was little occasion for serious fright, and the lesson of the occurrence is not as to the power of explosions, which we had no need of learning, but as to the weakness of glass, which also we might have known if we had thought a little about it. And I am not here suggesting that glass though so weak is not generally strong enough for its purpose.

The windows broken were generally large store and office windows at the street level, and they were broken by a sudden and, as we shall see, only a slight unbalancing of the normal atmospheric pressures upon their outer and inner surfaces. Here follows a concrete illustration of the strength of a large window to resist an excess of air pressure upon one side of it.

If we have a plate of glass 8 ft. square, which is not large as store windows go, the computed area of it will be 9,216 square inches. If there were a pressure of 1 pound per square inch upon that whole surface it would equal more than 4½ tons. A pressure of ¼ pound would give more than 1 ton on the glass, and a pressure of 1 ounce per square inch would equal a total load of 576 lbs.

We have some idea of what pressure plates of glass will stand by seeing what precautions are required in transporting them. They are generally carried on edge, and when they are laid horizontal a flat bearing is provided covered with bedquilts or other soft equalizing material, so that we know they will support little more than their own weight. Suppose a plate of glass 8 ft. square in a horizontal position and supported all around the edge, and then think of a man weighing 150 lb. stepping in on to the middle of it. The proposition is absurd, but then remember that a pressure of 1 ounce per square inch would equal the weight of more than three men. It is evidently much easier to realize what pressure a plate of glass will *not* stand than what it will stand.

An increase of 1 lb. per square inch in atmospheric pressure is indicated by a rise of 2 inches in the mercury column of a barometer. An increase of 1 ounce in air pressure is shown by a rise of ⅛ in. of mercury, while atmospheric pressure changes indicated by ½ in. of mercury are of almost daily occurrence and changes of 1 in. or more are frequent when storms occur.

Glass windows are of course exposed to all these atmospheric changes of pressure, but these take place slowly and they apply to both sides of the glass, so that the pressure upon one side of the glass normally balances that upon the other side. When the pressure upon one side of a large window becomes greater than that upon the other side, even to the amount of 1 ounce per square inch, we may say, as a general proposition, that the glass will surely break.

This difference of pressure on the two sides of a window easily occurs in the case of an explosion in the neighborhood, as, for instance, in subway excavations, the explosion causing some fluctuation from the normal pressure and the change occurring so suddenly that it cannot at once equally apply to both sides of the glass, and this is what happened in the New York harbor explosion on a large scale here under consideration. There was a great surge of air over a large area, so that more windows were broken than where small local explosions occur, but the action was of the same character.

This window breaking operation, however, was not so simple as thus far suggested. The windows were broken by sudden excess of air pressure, but they were not broken, as we might have expected, by an excess of pressure outside the windows. The broken windows tell an indisputable story to the contrary. They broke outwards and not inwards, leaving the piles of broken glass outside and not inside the windows. The windows were surely broken by air pressure, but it was the normal pressure of the air inside the window made suddenly effective by a reduction of pressure, or the creation of a partial vacuum, outside the window.

It is not so easy to say how this partial vacuum outside the broken windows was produced, and explanations differing somewhat in detail would be required for different localities. Remembering from what has been said above how slight a vacuum is required to explain the occurrences the accompanying crude sketch is submitted as applicable to one observed locality.

We are assumed to be looking south through a narrow down-town north-and-south street with a high skyscraper on the east side and low buildings of the long ago on the west side. The location of the explosion was across the harbor and in a southwesterly direction. Large windows in the first story of the skyscraper were broken outward and we may assume that a rush of air over the low buildings and coming from the general direction of the explosion curled upward for the moment against the face of the skyscraper and in the turn it quite naturally sucked in a little of the air in the street below, as indicated by the arrows, and, as is often known to occur in such cases, causing a slight diminution of pressure.

In some other locations in the city the explanation here suggested would apparently not apply at all. Washington Market covers a square area with a street on each of its four sides and large windows close together all

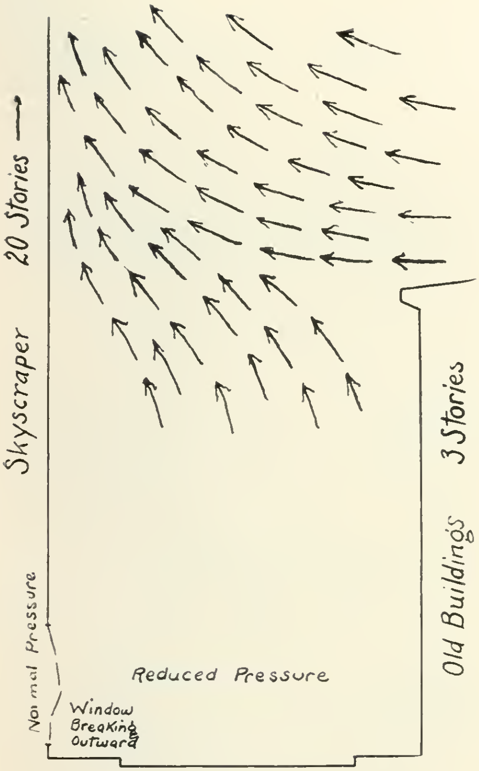


FIG. 2. WIND-INDUCED VACUUM.

around it. All of the windows on two sides of the building were broken and half of the windows on the other sides. Here there must have been a sudden reduction of pressure all around with no adjacent skyscrapers to cause the necessary eddies. We may assume a slight vertical undulatory movement of the entire body of air above the neighborhood accompanied by slight momentary reductions of pressure. The entire body of air within the building was free to act in all directions as there were no dividing walls or floors.

It is most essential to an understanding of this entire occurrence to remember how slight a reduction of pressure was sufficient to do the damage. Where wholesale breaking of windows occurs without any flying missiles it is not necessary to assume any terrifying conditions.

If two things are less than each other they are less than everything else.

SHANKING DRILL STEELS

BY CHARLES C. PHELPS

The methods employed in shanking and sharpening drill steels have been undergoing a decided change recently. This is due to the fact that hammer drills are now used to such a large extent. Every blacksmith has his own pet way of doing his work, but there are certain general principles and methods which, if followed, would produce much better results. Less attention also is being paid to the shanking than to the sharpening, although shanking is almost equally important.

Shanks on drill steels are of three general types—plain, collared and with lugs. Plain shanks are used principally with hammer drills, which employ an intermediate anvil block to transmit the force of the blow from the piston to the steel. There is little to be said about this type of shank except that it should be dressed up square, with correct dimensions, and should receive the proper degree of temper to suit the conditions under which it is to operate.

Correctly made and treated shanks will result in a lower maintenance cost for both steels and drills and will produce better drilling results, hence careful consideration of this matter will be amply repaid.

Fig. 1 gives the correct dimensions for shanks for jackhamer and No. 26 Leyner-Ingersoll drill steels. Here the shank is hexagonal with a round collar.

Figs. 2 and 3 give correct dimensions for No. 18 Leyner-Ingersoll shanks on $1\frac{1}{8}$ and $1\frac{1}{4}$ in. round steel respectively. Two lugs on the shank retain the steel in the chuck. It is absolutely necessary that the shanks should be made of the correct size. If the shank is too long, the power of the blow will be reduced, and if too short, the front head will be compelled to take part of the blow. The shank lengths specified on the illustrations provide for inevitable wear, but this should not be permitted to proceed too far. In the case of the No. 18 Leyner-Ingersoll shank, for instance, it is unsafe to use a steel after the length of the shank, from the lug to the end, has been reduced by wear from $3^{13}/_{16}$ to $3^{9}/_{16}$ in. The correct diameter of shank is of equal importance, as too loose a fit will permit side play. The same effect is produced by permitting the front chuck bushing to wear to too great an extent before replacing. The striking face of a hammer-drill steel should be smooth and true. If this is overlooked, the piston will not strike the shank squarely and will soon start to chip. It is hardly necessary to refer to the injury that may be done to the interior of the drill by such chips of metal. The end of the shank may be trued by grinding on an emery wheel after hardening, or if this is not convenient, it may be filed before hardening. The edge of the striking face, should also be beveled off, to prevent subsequent burring of the metal. In squaring the shank end it is not safe to depend on the eye unaided; the use of a small metal square is recommended. The end of the piston may also in time become worn somewhat concave. Should this occur, a square shank will tend to chip it, as in Fig. 4. The obvious remedy is to grind the piston off square should it become belled on the end.

In the case of hollow steels for water-feeding drills, particular care must be taken to see that the hole is enlarged sufficiently to permit the entrance of the water tube without danger of breaking the latter. The enlarged section must be central and must be carried for a sufficient distance. Fig. 13 illustrates a gage which is convenient for proving up the diameter and concentricity of the enlarged hole.

COLLARS FORMED BY HAND

The first operation in forming collars on jackhamer and No. 26 Leyner-Ingersoll steels is to heat the steel to a cherry-red (1,500 degrees F.) for a distance of 5 in. from the end; then cool the end by immersing in water to a depth of 3 in. The remaining 2 in. of heated steel is then upset by bouncing on an iron plate. The shank is reheated to cherry-red, a center punch is driven into the end of the steel to enlarge the hole and prevent it from closing during forging. The steel is then placed between bottom and top collar swages shown in Figs. 15 and 17 and the collar is formed by hammering the latter, rotating the hexagonal steel between blows.

After a third heating to cherry-red, the punch is again inserted and the shank is swaged with the shank swage, Fig. 19, until the gage, Fig. 14, will slide over the shank. After again heating as before, the shank end is marked with the aid of the shank gage, and is cut off as in Fig. 12, employing a chisel of the type shown for the purpose. The shank end should be dressed up square and smooth with a file at this stage, unless this is to be done later by grinding. The shank is then ready for hardening.

FORMING LUGS BY HAND

The same general rules apply to the formation of lugs on shanks for No. 18 Leyner-Ingersoll drill steels. There are a few differences, however, as will be explained. The steel is heated to a cherry-red (1,500 degrees F.) for each operation. The first heat is for 5 in., after which 3 in. of shank is cooled in water. The heated part is then upset. After the second heat the bottom swage, Fig. 18, and the lug-side former, Fig. 20, are employed On the next heat the lug-diameter former, Fig. 21, is struck with the hammer while the steel is held in the other part of the bottom swage. On the same heat the lug-side former is again applied. During these operations the hole is kept open with the center punch. On the next heat the top swage, Fig. 22, is applied on both sides of the lugs to finish the ends of the lugs and round up the shank. Fig. 16 shows the shank gage used with these steels. After reheating, the steel is cut in the same manner as previously indicated, using the gage as a guide. The shank-end former, Fig. 23, insures the end being the correct diameter, with the hole central and of the correct size. It also helps to square up the end and round off the edges. After the sixth and final heat the shank should be hardened.

If the steel was heated and collared in a shank-forming appliance in one operation, the result would be likely to develop a "cold shut," as illustrated in Fig. 5. Here it is apparent that the hole tended to enlarge more rapidly in proportion to its size than the collar, leaving the metal folded down on itself. To obviate this condition, the steel is partly upset until it assumes the form shown in Fig. 6, in which the hole is considerably enlarged and the collar but slightly formed. The next operation is to form the steel down to its original section, as shown in Fig. 7. This leaves the hole almost closed and the stock considerably upset at the point where the collar is to be formed. With the hole in this condition, it cannot enlarge as in Fig. 7, but on the contrary, when the steel is placed in the machine and upset, the hole takes the form shown in Fig. 8. By

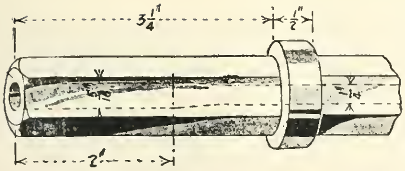


FIG. 1

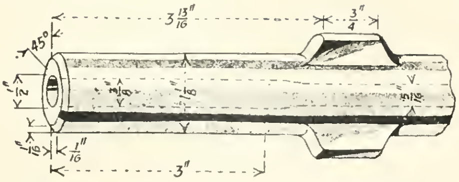


FIG. 2

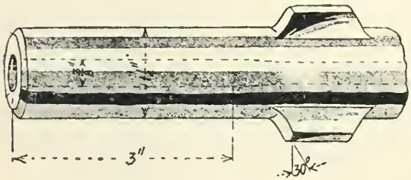


FIG. 3

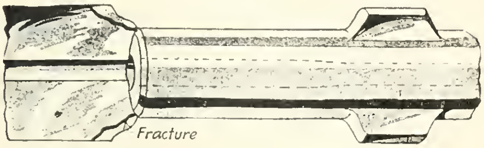


FIG. 4

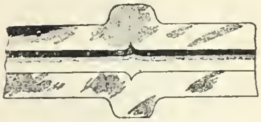


FIG. 5

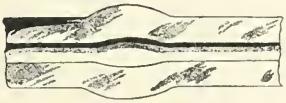


FIG. 6

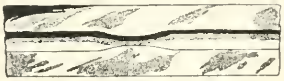


FIG. 7

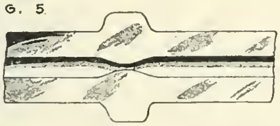


FIG. 8

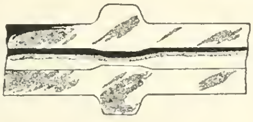


FIG.

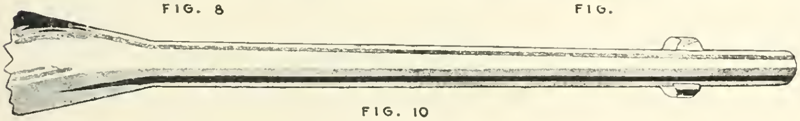


FIG. 10

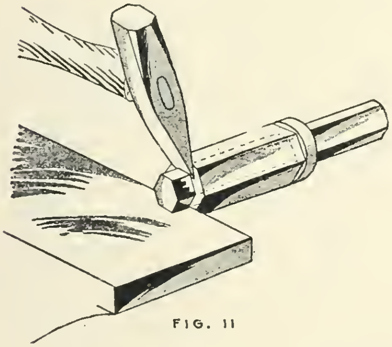


FIG. 11

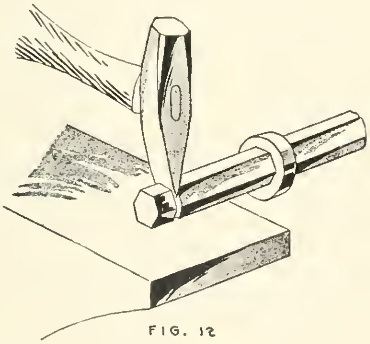


FIG. 12

SHANKING DRILL STEELS.

the use of the drifting pin the hole is formed as shown in Fig. 9.

All dimensions are taken care of by the standard equipment. When a shank-forming appliance is used, a pin-puller which bolts on the side of the machine will be found of great assistance in removing the steel pins which it is necessary to insert in the hole of the steel during the several forming operations. The pins are removed from the steel by resting the end of the shank against the face of the pin-puller, clamping the pin by bringing down the small lever and forcing the pin out by throwing over the long lever.

HARDEN SHANKS CAREFULLY TO AVOID BREAKAGE

One of the most prolific sources of shank breakage is improper hardening. Plunge-tempering is more rapid than draw tempering, and it is considered more practical in every way. It is recommended to heat the shank slowly and evenly to a cherry-red (1,500 degress F.) considerably beyond the collar or lugs; a total distance of 7 in. gives good results. Collared steel should then be quenched in oil, which will impart a suitable degree of temper. Steel with lugs should first be dusted by throwing a small handful of powdered yellow prussiate of potash on the shank and especially around the lugs; this increases the hardness of the metal on the surface and greatly improves its wearing qualities. The shank is then quenched in oil.

Fish oil and lard oil are recommended for this purpose, and it is advisable to keep the oil cool, which can be done conveniently by placing the can of oil in cold water. Shanks should never be quenched in water for it makes the steel entirely too hard, which tends to cause fracture of the drill piston. On the other hand, should the heat treatment not be such as to give the shank sufficient hardness, the end will become upset and will in time cut off the water tube.

PRECAUTIONS IN USING STEEL

When drilling or when sharpening steels, care should be taken not to set them aside with the shank ends in the earth, as dirt or pebbles will enter the hole in the steel or lodge on the end, resulting in extra wear or perhaps even breaking a water tube. It is much safer to stand the steels with bit ends down or place them flat. The drill runners should always make sure that the shank end is clean before inserting a new steel in the chuck.

The piston, chuck-bushing, chuck keys and other parts subject to wear should be inspected at regular intervals. The proverb of the stitch in time applies with full force to rock drills. Proper lubrication is a subject which principally concerns the drill, and a drill properly lubricated will keep the shank and chuck in a sufficiently well-lubricated condition to keep down wear of these parts as much as possible. The blind starter, Fig. 10, is most useful for squaring the rock before starting ₋ hole. If it were used to a greater extent for this purpose, it would eliminate subsequent delay and difficulty in many cases, for it is a well-known fact that a hole can be started much quicker against a flat rock surface and the hole will be more likely to remain in line. With reduced rifling tendencies, there is less strain on the steel and chuck parts and less time wasted through having the drill hung up. "Tending chuck" with a bar is also reduced with its attendant injurious features. The reduction of lost time in drilling is a factor not carefully watched in the average mine.—*Eng. and Min. Journal.*

THE SAND BLAST IN THE MODERN FOUNDRY

The following is a brief abstract of an elaborate and copiously illustrated article by H. Cole Estep in *The Foundry*, September, 1916.

A sand-blast installation is one of the absolute essentials of the modern foundry, coming close after the melting furnace and the cranes in importance. Introduced largely for its ability to import a superior surface finish, the sand-blast has other important advantages among which are cheapness and rapidity of operation.

The sand-blast with its adaptability of conditions applies to almost the entire product of the foundry. It is good for all casting surfaces to be painted or enameled and is employed almost exclusively in ornamental iron foundries. The sand-blast not only does the work effectively and quickly, but also preserves all of the delicate outlines and sharp edges. In steel foundries the sand-blast is particularly effective in removing the hard, burnt sand that clings so tenaciously. It is good for the smallest as well as the largest work produced.

On account of the cost of installation it does not appeal so much to the little foundries, but the larger and the largest plants cannot live without it. Besides the cost of the mechanical equipment the labor problem is serious, and this largely because it has been customary to employ only the cheapest grades of labor. Skill and judgment are required for this work, and for these there is no substitute. A skilled and experienced operator will not only turn out better work and more of it but will show savings in air consumption and other running expenses. Until a comparatively recent date, however, it has been difficult to obtain good

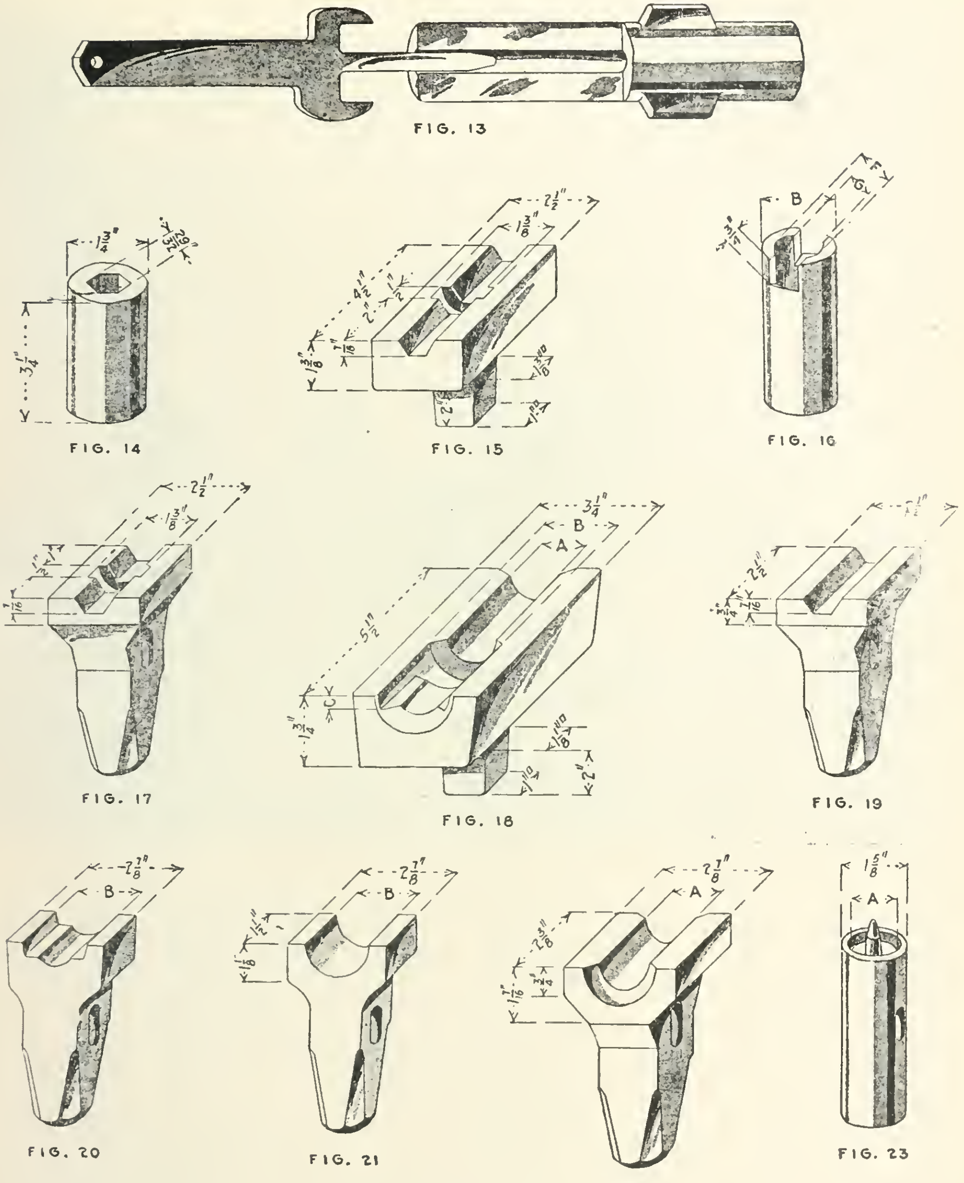


FIG. 13
FIG. 14
FIG. 15
FIG. 16
FIG. 17
FIG. 18
FIG. 19
FIG. 20
FIG. 21
FIG. 22
FIG. 23

SHANKING DRILL STEELS.

men for the work on account of the humanly barbarous conditions under which much of the work has been done. At present, by installing a proper dust exhaust system and providing the operator with suitable protective devices it is possible to make the conditions under which the work is done entirely comfortable and healthful.

Although the sand-blast is an American invention, dating back to 1870, it has found its highest appreciation and most elaborate employment in Europe, especially in Germany and Switzerland. A complete modern sand-blasting installation includes not only the sand-blast machine itself, but means for handling the dust, screening and treating the sand and providing the necessary compressed air. The tendency is toward the development of self-contained apparatus which embodies all the functions except the compressing of the air.

Referring to the sand-blasting jet, there are two general types of machines in use, the gravity type and the pressure type. In the former the sand is propelled by a jet of air striking it as it trickles down from an overhead sand tank. In the latter type of machine the sand tank is closed and under pressure. This permits the use of much higher pressures, which are particularly necessary for sand-blasting steel castings.

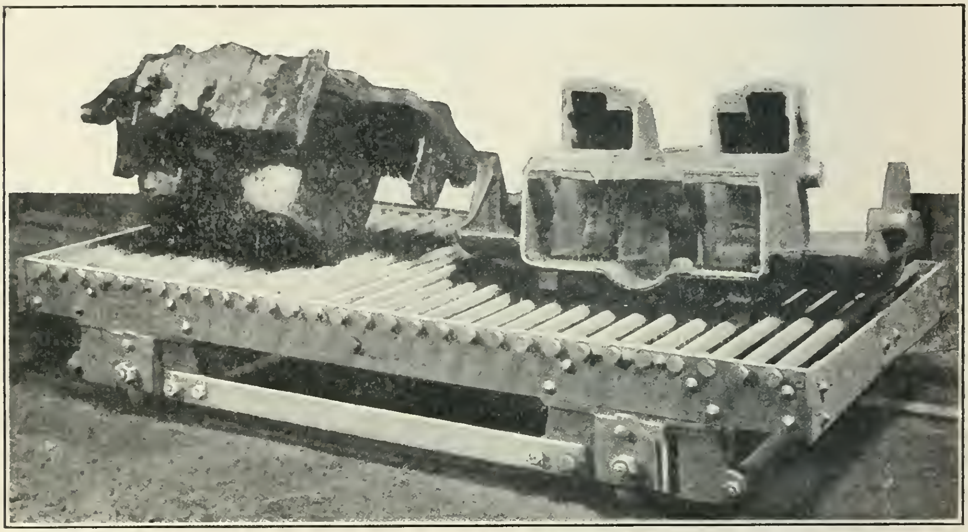


FIG. 1. BEFORE AND AFTER SAND BLASTING—SPECIAL SAND BLASTING CAR.

The four principal types of sand-blasting apparatus as a whole which have been developed include sand-blast rooms, sand-blast tumbling barrels, rotary table sand-blast machines and sand-blast cabinets. Each of these has its particular field of application. Although the sand-blast has been developed to a high state of perfection it has as yet little scientific basis. The preparation of a proper equipment for a given plant is still a matter of judgment based on experience. The selection is influenced or determined by a large number of factors, including the weight and outline of the castings to be handled, the degree of finish required, the character of the facings used in the mold, the kind of sand, shot or crushed steel used in the blast, the temperature at which the castings were poured, the skill of the operator, etc.

AIR PRESSURE

There is considerable difference of opinion as to the proper pressures which should be used for sand-blasting work. The consensus seems to favor moderate pressures for gray iron and the non-ferrous metals and higher pressures for steel. A modern authority recommends 20 pounds per square inch for brass and aluminum castings, 20 to 40 pounds for gray iron work and 80 pounds for steel, and these pressures appear to be those generally employed at the present time. It is advisable to use as low a pressure as possible compatible with satisfactory and rapid work, in order to keep down the air consumption.

Taking, for example, a sand-blast for cleaning gray iron castings using 20 pounds pressure through a ½ inch nozzle, the free air required per minute would be about 120 cubic feet, and to compress this air to 20 lbs. would require about 9 horse power, while to compress the same quantity to 80 pounds would require 23 horse power. If a low pressure machine is used in a foundry where the air is used at 80 pounds for pneumatic tools and other purposes a reducing valve may be employed, but in this case a large portion of the excess of horse power required for the high com-

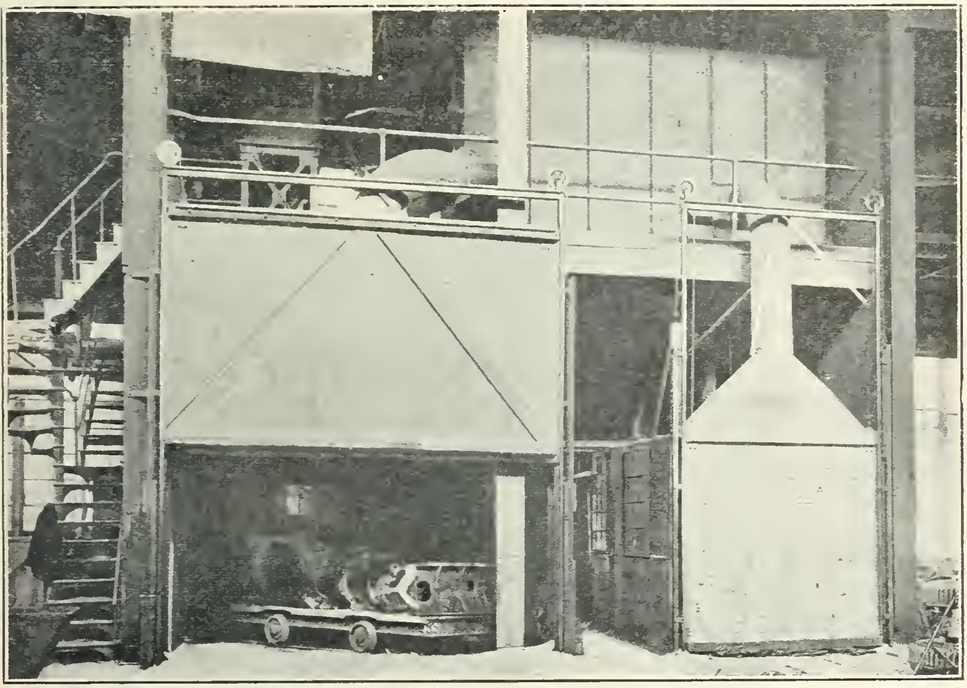


FIG. 2. MODERN SAND BLAST ROOM WITH SPECIAL EXHAUST.

pression would be lost. In the case just cited the difference in horse power for a year would nearly pay for a special compressor for the sand-blast alone.

Owing to the fact that practically every modern foundry is supplied with electric power, there is a decided tendency to equip sand-blast apparatus operating at less than 80 pounds with special motor driven compressors. This prevents loss of power and avoids taking air for the sand-blast from the main air lines, and it also tends to make the apparatus self-contained.

FOR CLEAN, DRY AIR

When pipe lines are busy from the compressor to the sand-blast, traps or other arrangements should be provided to separate the moisture from the air. Excessive amounts of oil in the air also are bad, and engineers operating compressors furnishing air for sand-blast apparatus should be continued against to great liberality with the lubricant.

SAND-BLAST NOZZLES

The design of the sand-blast nozzle has much to do with the air consumption. Up to date machines are provided with nozzles which at the beginning may be theoretically correct for the work. Inasmuch, however, as no material has yet been discovered which will resist the abrasive action of the sand, all nozzles wear rapidly and if this is allowed to go too far the increase in air consumption may become very serious. Where a ½ inch nozzle operating under 30 pounds pressure consumes 161 cubic feet of free air per minute, requiring about 16½ horse power for the compression, the air consumption will be increased to 252 cubic feet, requiring 26 horse power, if the nozzle is permitted to wear to ⅝ inch diameter. As the nozzles are cheap they should be renewed frequently.

In a series of tests at Ohio State University it was found that for a constant distance of 8 inches, at a constant angle of 45 degrees between the nozzle and the surface sand-blasted, the equivalent amount of free air delivered per minute, the iron removed, the sand discharged and the sand used per 100 cubic feet of free air flowing per minute vary directly with the pressure. The per cent. of usable sand remaining and the amount of sand discharged per pound of iron removed vary inversely with the air pressure in the machine. It was also found that with a constant pressure of 60 pounds in the machine and a fixed distance of 8 inches from the nozzle to the work the greatest amount of metal was removed and the least amount of sand was required to do it when the angle was from 40 to 60 degrees.

The fact that the efficiency of the process varies directly with the amount of usable sand remaining in the machine makes it necessary to provide apparatus for separating the dust or shattered sand from the good sand before the material is again run through the nozzle. A means of properly effecting this separation is provided with every modern sand-blast installation.

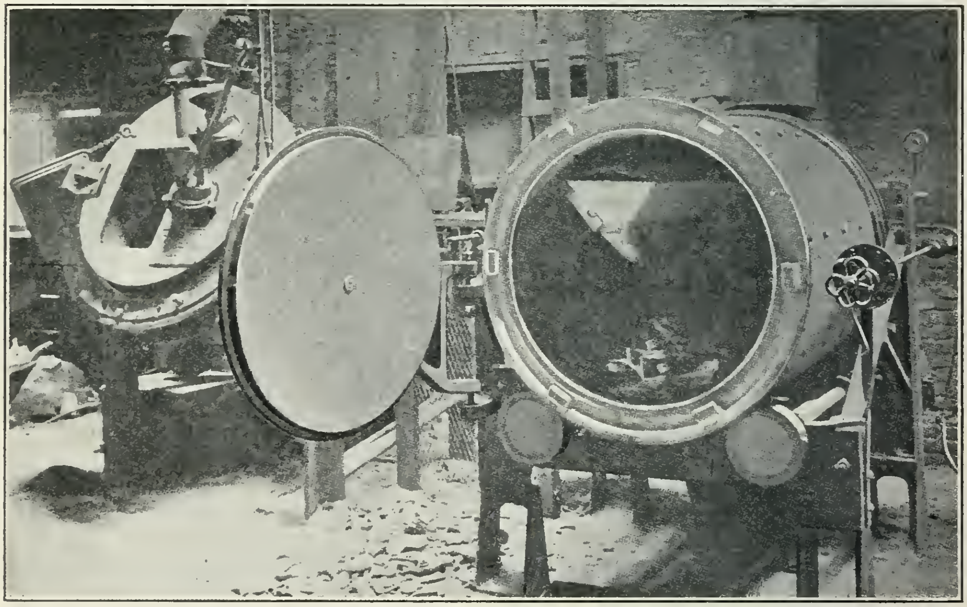


FIG. 3. AUTOMATIC SAND BLAST BARRELS.

TAKING CARE OF THE DUST

The subject of dust control has occupied a large share of the attention of sand-blast designers in the last few years. Sand-blasting is of necessity a dusty operation, and to the fact that early designers did not give this feature sufficient attention was due the slow progress made by the sand-blast in its earlier years. Until comparatively recently so-called open air sand-blasting was attempted, but invariably with indifferent success. It is perfectly feasible to control the dust so that it will not be in the least troublesome. If the work is of such a nature that it can be handled in a sand-blast barrel, or in a rotary-table or cabinet type machine, no dust is discharged into the room. These machines are fitted with exhaust fans which remove the dust and discharge it into some suitable form of collector.

Three forms of dust collectors are employed, including the centrifugal, the dry screen and the wet types. In the centrifugal, the dust is exhausted into a large container in which it is given a swirling motion. The heavier particles are thrown to the outside where they are caught by baffles and conducted to the bottom of the receiver. In the dry screen type of dust collector the air is carried through a series of fine screens on which the dust gathers. Usually a mehanism is provided for rapping the screens to knock off the dust, permitting it to fall into collection hoppers at the bottom. In the wet type of dust collector, or scrubber, the air is forced to pass through fine sprays of water which wet the dust particles, causing them to coalesce until they become sufficiently heavy to fall to the bottom of the apparatus from which the sludge is removed at intervals.

Unless proper dust removal apparatus is provided, the workmen in sand-blast rooms are in constant danger of contracting tuberculosis. One modern authority states that seven changes of air per minute are necessary to insure proper living conditions in a sand-blast room. It is also stated that in many installations not more than two changes are provided. There is a strong tendency among designers to greatly increase the volume of air passing through the room. In many states laws have been passed compelling the abatement of the dust nuisance, but progressive foundry men do not need legal enactments to force them to provide satisfactory working conditions. It is as much to the proprietor's advantage as it is to that of the employe that sand-blasting be satisfactorily conducted.

Besides clearing the air of the room sand-blast helmets are now provided, which practically exclude dust even though the operator is compelled to work under conditions otherwise unfavorable. Respirators also may be used, although none yet devised is efficient for continuous use in connection with sand-blasting.

Fig. 2 shows a recent installation furnished the National Steel Foundries, Milwaukee, by the Hoevel Manufacturing Corporation, New York. In this sand-blast room the floor, the ceiling and two sides of the chamber are provided with slots through which the exhaust fan sucks the air. The slots are so arranged that an air veil is formed which, it is said, cannot be penetrated by the dust. This veil divides the chamber into two parts. The dust developed underneath the air veil is sucked away from the room as soon as it arises so that the workman, who stands above the dust zone, is not molested in any way.

The entire equipment of this plant includes two sand-blast chambers, the largest of which is 18½ by 14 feet and 8½ feet high. The smaller chamber is 13 by 8 feet and also 8½ feet high. The grated floor of the larger chamber is fitted with a turntable which is designed to carry a weight of 30 tons, and as the work proceeds this turntable is slowly rotated, which enables the operator to sand-blast the castings on all sides without changing his position. The movement of the turntable is controlled by a lever inside the sand-blast room. The used sand falls through the floor grating into two hoppers from which it passes through two sieves and then into troughs leading to screw conveyors. These carry the sand to a point under the rear of the room where it is discharged into a bucket elevator. The elevator delivers the sand to a separator from which it is discharged into a hopper over the tank of the sand-blast machine. The sand is held back by a valve which opens automatically when the air pressure is applied to the nozzle. At the two rear corners of the room there are vertical openings to admit fresh air from the outside, and there is also a horizontal slot at the top of the back wall which provides further ventilation. The opening for the exhaust is in the ceiling at the front of the room. The fan exhausts 12,250 cubic feet of air per minute, thus changing the entire contents more than five times in that period.

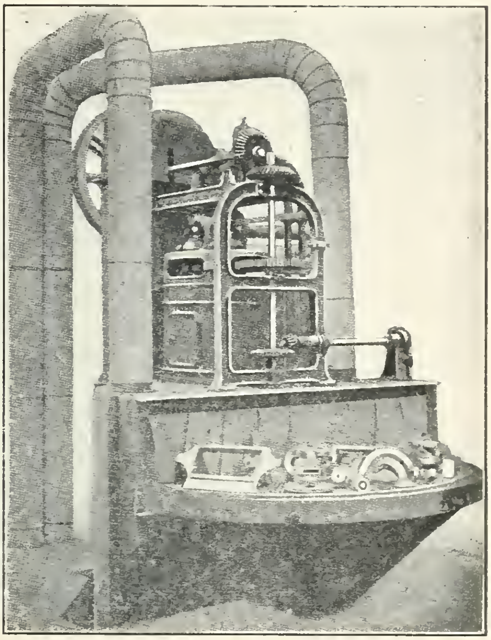


FIG. 4. ROTATING TABLE MACHINE.

The high-pressure air for the sand-blast machine is delivered from an air main carrying 90 pounds per square inch. It is discharged through a reducing valve which cuts down the pressure to 65 pounds for use in the machine. The sand-blast tank is 41 inches in diameter by 79 inches high and has a capacity of about 460 pounds. A ⅝ inch nozzle is used. The two sand-blast rooms at this plant handle about 45 tons of castings a day, and this tonnage probably could be increased if there were

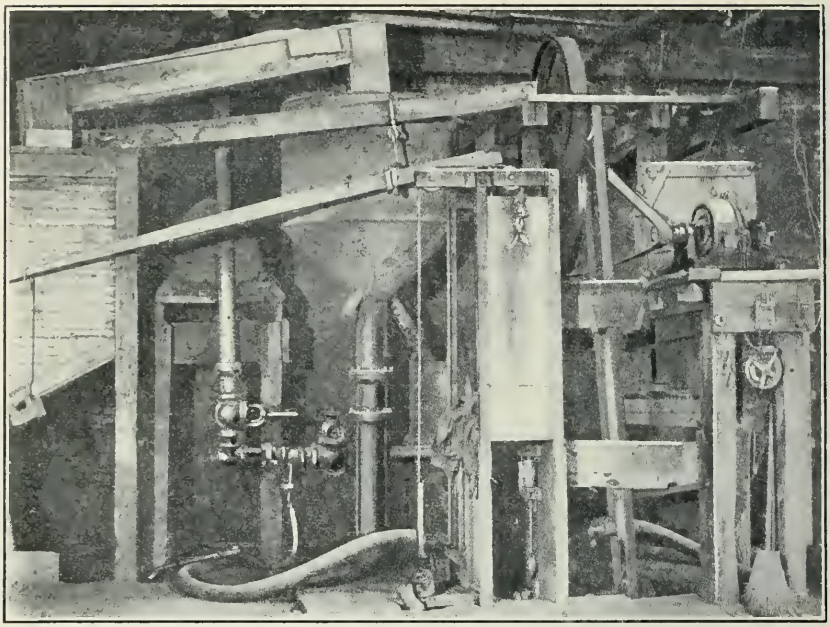


FIG. 5. PLANT FOR CLEANING CAR WHEELS.

some arrangement whereby two trucks could be used for each room.

The article from which we are abstracting gives descriptions similarly complete of several other sand-blast installations showing quite different arrangements of details.

For handling small castings the sand-blast barrel has many advantages, including low first cost, ease of installation and freedom from dust. Fig. 3 shows a typical sand-blast barrel installation especially designed for handling malleable castings. The barrel at the right was furnished by the New Haven Sand-Blast Co. and that at the left by the W. W. Sly Mfg. Co., Cleveland. These machines will handle about 500 pounds of castings in from 15 to 20 minutes.

The rotary table sand-blast machine was developed primarily in Germany. An American successor of the German machine as sold in the United States by the Hoevel Mfg. Corporation, New York, is shown in Fig. 4.

The capacity of a rotary table sand-blast machine does not depend entirely upon the size and weight of the pieces to be cleaned, but to a large extent on the manner in which the surface of the table is utilized. In order to obtain the highest efficiency the table should be covered very closely and the open spaces should be filled up with small castings. This will not only increase the output, but will also save the surface of the table from unnecessary wear.

SAND-BLASTING CAR WHEELS

For sand-blasting car wheels the special apparatus shown in Figs. 5 and 6 has been developed. This machine is in use at the plant of the National Car Wheel Co., West Holmestead, Pa. The company is now making 600 33-inch car wheels a day, weighing from 625 to 840 pounds each. Both sides of the wheel are cleaned at the same time. One

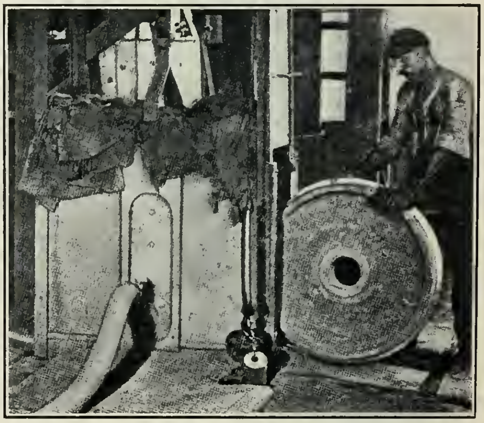


FIG. 6. ROLLING WHEEL INTO POSITION.

man rolls the wheels into the machine, another removes them and a third works the sand-blast. As high as 650 wheels have been cleaned in this machine in a day. It is operated by a 7 horse power Westinghouse motor. The sand is fed from a large storage room in the cellar to a reservoir above the machine by a Sturtevant No. 6 fan. A 15 horse power operates the fan which also is used to remove the dust.

After a wheel is rolled into the machine, the operator opens a valve connected with a tank carrying 25 pounds air pressure. Two hose and pipe connections tapering from 4 inches to ¾ inch in diameter lead from the tank to each side of the sand-blasting chamber. The nozzles are lowered and raised from the rim to the hub of the wheel by a hand operated lever. The surplus sand is carried from the chamber by small buckets on an endless belt. A steel curtain is lowered after the wheel is rolled into the chamber to protect the operators. This machine was designed by the Tilghman-Brooksbank Sand Blast Co., Philadelphia.

THE SAND

The value of the sand-blast depends upon the quality of the sand, and this item may become an important one in the expense of operating. The sand should be hard and clean, also free from clay, soil, mica or other substances which tend to create dust and have no abrasive value. The trend of thought seems to be that such qualities as hardness and resistance to the shock of impact are more essential than more sharpness. It is generally believed that it is the impact of the moving particles that does the work, actual cutting action being negligible.

Instead of sand, steel shot is quite extensively employed. Metallic shot or crushed steel has a specific gravity of about two and a half times that of sand. For this reason the impact is heavier, and this material is said also to have unusually satisfactory wearing qualities.

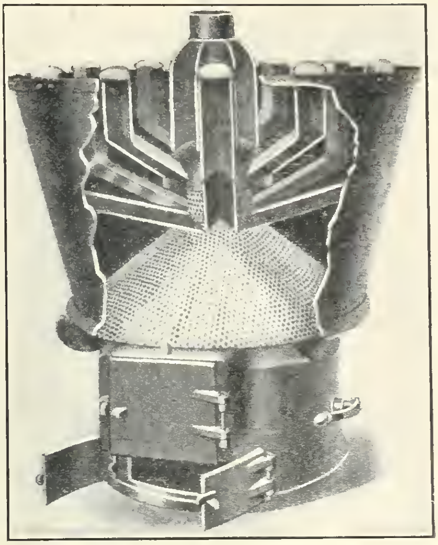


FIG. 7. SAND DRYER.

If wet sand is shipped it should be dried before it is placed in the machine, either by spreading it over a large area, as the floor of a shed, or by using a specially constructed dryer for the purpose. A hopper dryer erected around a small stove or steam coil may be employed. An interesting form of sand dryer manufactured by the Pangborn Corporation, Hagerstown, Md., is shown in Fig. 7. This apparatus keeps the wet sand from direct contact with the fire box and carries away the moisture by currents of air. This is accomplished by the use of a perforated cone shaped screen, the neck of which surrounds the chimney. As fast as the sand is dried it drops through the perforations in the screen onto the inclined surface of the fire box, from which it falls to the floor. As the sand resists the passage of air and heat, a number of inverted angle flues project from the fire box through sand to the hopper. This permits the hot sand to absorb the moisture of the sand and to discharge it through these flues.

HOSE

Among the various items of sand-blast equipment which are subject to wear the hose is an important element. Only the best qualities of rubber hose especially made with a thick inner wall of pure rubber will withstand the cutting action of the sand for any length of time. Of course any grade of hose may be used, but that which is not reinforced internally will not last long. In actual service it will often be found that the wear on the hose is fully as great on the outside as within, due to its being dragged over rough castings. The best of hose may be spoiled by the operator kinking it up under his arm, although this is sometimes a conveinent way of stopping the flow. When not in use the hose should be hung over a curved hanger. An excess of oil in the air is very destructive to all rubber hose.

Gloves, helmets and goggles are all essential and have been greatly improved in recent years. Helmets especially may be secured which are virtually dust tight. The sand-blast helmet made by the Multi-Metal Separating Screen Co., New York, is provided with a window consisting of four multiple screens which will admit light and air and at the same time prevent the sand from sifting in.

FEEDERS AND BURNERS FOR POWDERED COAL*

BY C. J. GADD

Powdered coal feeders are of two kinds, one type consisting of a mechanically operated screw or flight conveyor having a variable feed, the other type consisting of a siphon through which the fuel is fed by the medium of compressed air, the feed being regulated by the air pressure.

Burners for powdered coal are operated under either low or high pressure. Low pressure burners are used with an air blast varying from two ounces to eight ounces. High pressure burners are used with compressed air varying from forty to one hundred pounds pressure.

Fig. 1 illustrates a sectional elevation of a mechanically operated low pressure feeding apparatus for coal dust, also a sectional view of the feeder taken across the air-blast ports, showing the method of its connection with the burner.

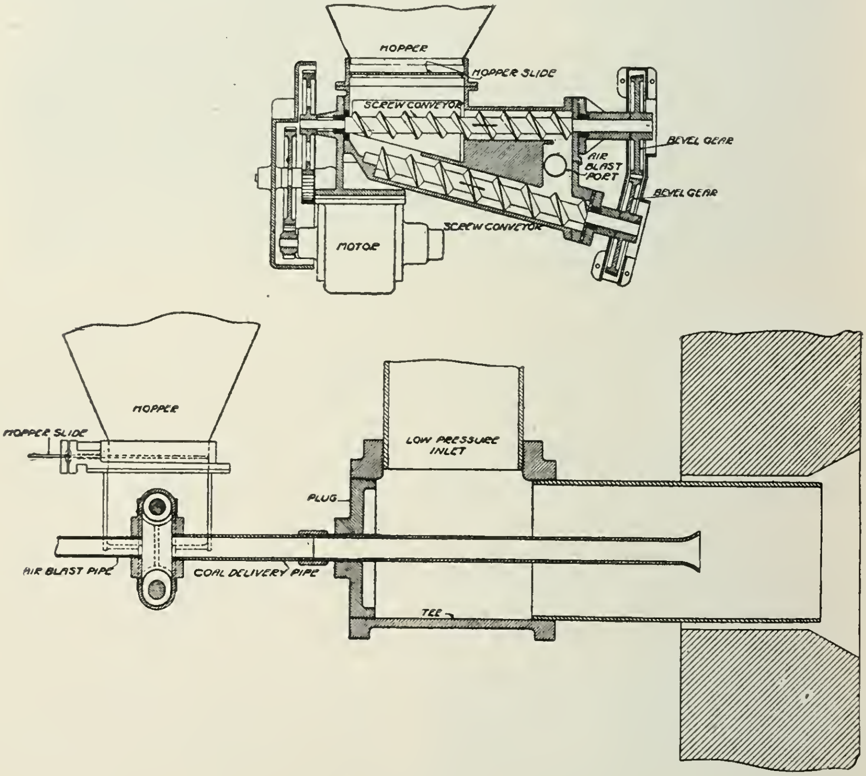


FIG. I.

By referring to the secional elevation it will be noted that from the hopper the horizontal conveyor screw delivers a stream of coal in the direction of the arrow mark, which falls as a continuous shower past the air-blast ports, and is picked up by a cross-stream of air

---

*From a paper entitled "The Use of Powdered Coal in Metallurgical Processes." Journal of the Franklin Institute, September, 1916.

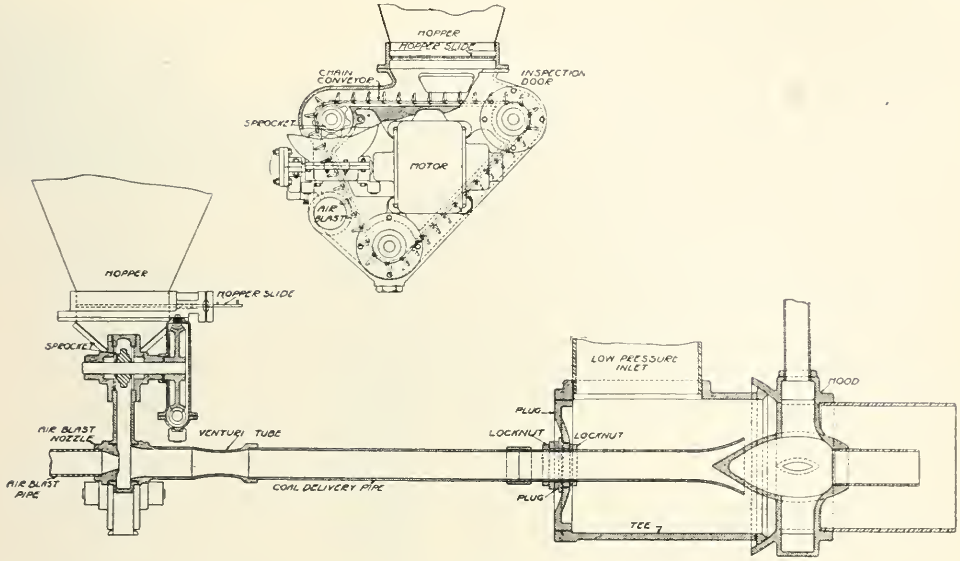


FIG. 2.

which delivers the mixture through the coal-delivery pipe to the burner.

The quantity of fuel delivered by the conveyor screw is regulated by varying the speed of rotation, which in this case is obtained through a direct connected variable speed motor. The amount of fuel taken up by the cross current of air will vary with the pressure of the air blast, which is controlled by a suitable valve placed in the blast line. Any excess fuel escaping the feeding action of the air blast is automatically returned to the hopper by the lower inclined conveyor screw.

The coal delivery pipe discharges its mixture into the burner, the low pressure inlet pipe furnishing the necessary additional air for combustion, and the resultant mixture is discharged into the furnace.

Fig. 2 shows a sectional elevation of a mechanically operated low pressure powdered coal feeding apparatus, also a sectional view

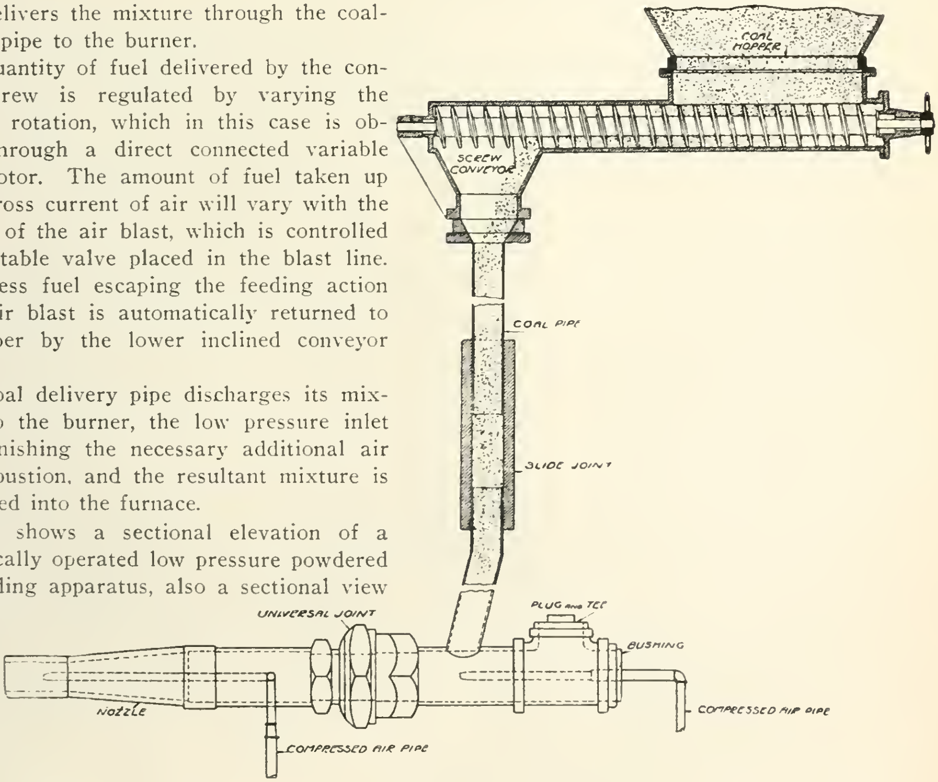


FIG. 3.

of the feeder taken across the air-blast ports, showing the method of its connection with the burner.

By reference to the sectional elevation it will be noted that in this device an endless flight conveyor chain is used for feeding a stream of powdered coal in a continuous shower across the air-blast ports, and the excess fuel escaping the feeding action of the cross current is automatically returned to the hopper by the endless flight conveyor chain.

Variable fuel feed is obtained through a direct connected variable speed motor, and the amount of fuel taken up by cross current of air will vary with the pressure of the air-blast.

The air-blast inlet nozzle connecting with one side of the feeder case is reduced, the outlet side being flared, beyond which is a Venturi tube used to induce higher velocity of the mixture leaving the feeder, thereby causing a slight vacuum or pull throughout the case, the mixture continuing through the coal-delivery pipe to the burner. The cone extension on the hood of the burner enters the flared end of the coal-delivery pipe, breaking the solid shaft of coal and air deflecting it around the inner periphery of the burner pipe. The mixture takes the form of a hollow ring, in the centre of which an auxiliary blast is discharged, giving a very thorough atomization of the particles as they enter the furnace.

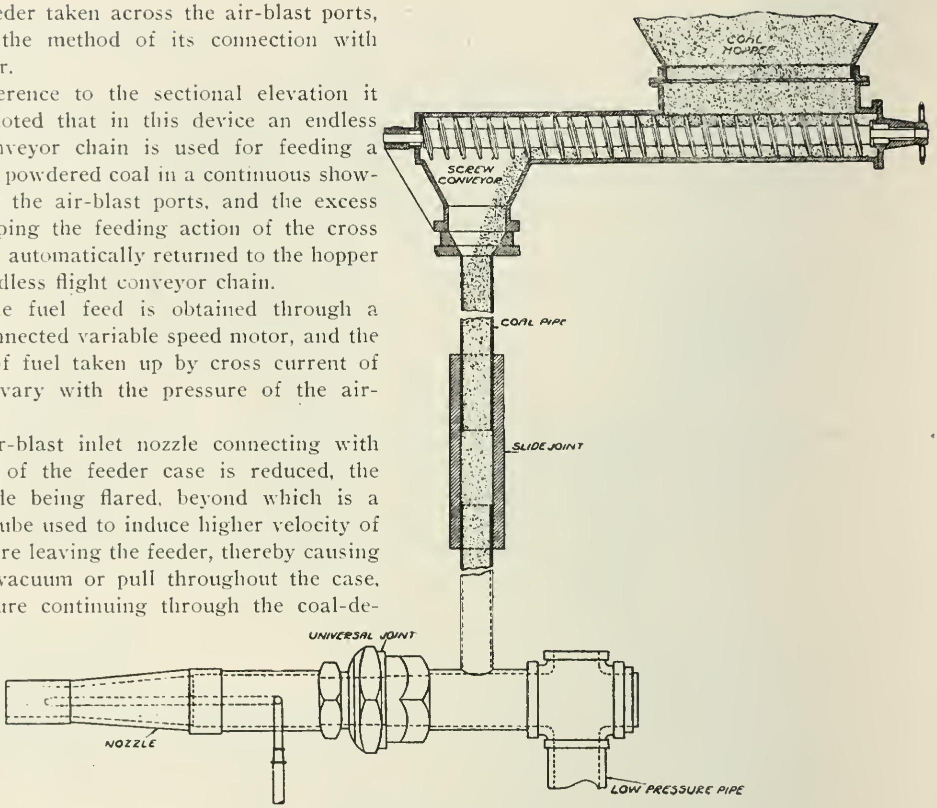


FIG. 4.

Figs. 1 and 2 serve to illustrate two forms of low pressure mechanical feeders and burners in commercial use, modifications of which are also in successful operation, all involving the same general principle; namely, a mechanism which will give a uniform and properly proportioned mixture of coal and air, both under variable control, feeding the resultant mixture in a thoroughly atomized state into the furnace.

Feeders and burners of this type are used almost exclusively on the many forms of heating furnaces in the metallurgical arts. This method of burning powdered coal with low velocity of both air and coal produces a short flame, as the fuel combusts almost the instant it leaves the burner, and the heat thus produced is conveyed by the gases from the initial point of firing with less cutting action upon the material being heated and on the brick work.

Powdered coal will flush, and when once started will run like water. Screw feeding devices should, therefore, be made very long and of a reasonably fine pitch in order to set up enough friction and baffling action to prevent the coal from flushing through the feeding mechanism and causing irregular feed.

In the case of the feeding mechanism shown in Fig. 1, long screws would make a cumbersome and expensive device, and efficiency has been sacrificed in this form of feeder for the sake of compactness and cheapness, as feeders of this design will invariably flood. They have another very objectionable feature;

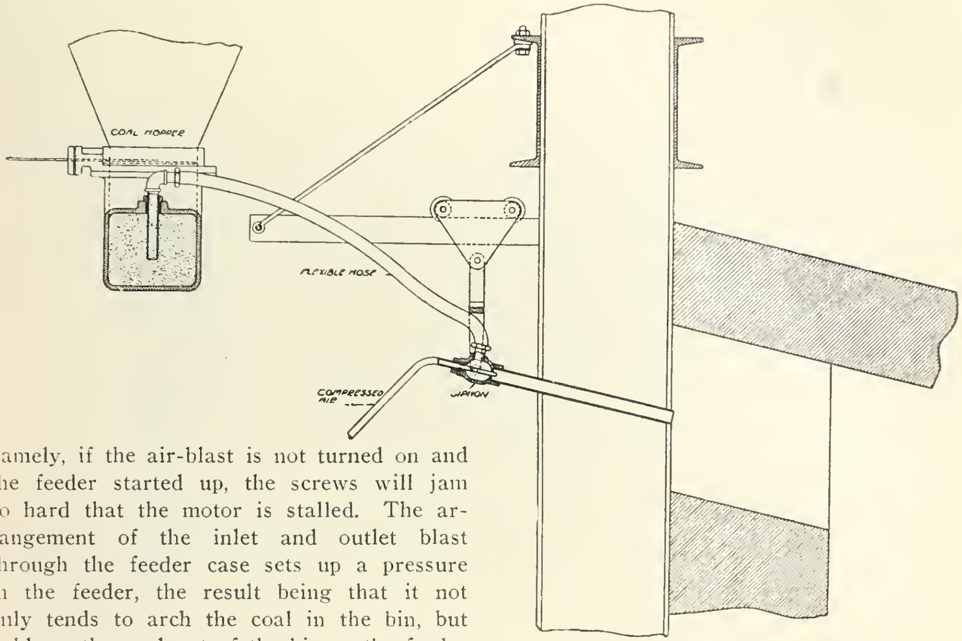


FIG. 5.

namely, if the air-blast is not turned on and the feeder started up, the screws will jam so hard that the motor is stalled. The arrangement of the inlet and outlet blast through the feeder case sets up a pressure in the feeder, the result being that it not only tends to arch the coal in the bin, but it blows the coal out of the bin or the feeder case, wherever a leak may occur. In addition, under normal running it consumes considerable power to operate.

In Fig 2 the vertical flights and the conveyor chain have a baffling action which prevents flooding. Under operating conditions it has been proved that the coal will not pack in the feeder should the air blast be cut off. The air blast nozzle and the Venturi tube, producing a suction through the case, have a tendency to prevent arching in the hopper, thus giving a more reliable and uniform feed. In addition, this suction prevents leakages, as there is always an inward pull on the case. This type of feeder takes one-tenth of the power to operate it as compared with the same capacity of screw feeding device shown in Fig. 1.

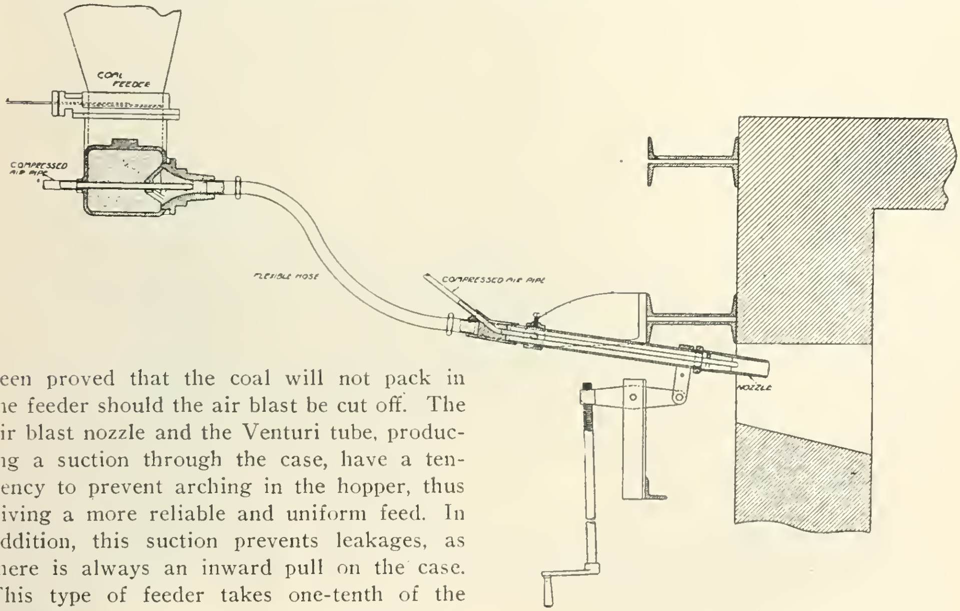


FIG. 6.

Fig. 3 shows a sectional elevation of a mechanically operated high-pressure powdered-coal feeding apparatus. By reference to the drawing it will be noted that in this device a long screw of fine pitch conveys the coal from the hopper and discharges a uniform stream of powdered fuel into the coal pipe. This stream falls by gravity down the coal pipe and is picked up by a cross-jet of compressed air as it enters the burner. The expansion of the compressed air in the larger diameter of the burner thoroughly mixes the coal and air, and this mixture is injected from the burner into the furnace at high velocity by the compressed air jet at the end of the nozzle.

By varying the speed of rotation of the conveyor screw variable fuel feed is obtained.

Fig. 4 illustrates a sectional elevation of a mechanically operated high pressure feeding apparatus for powdered coal which is similar in every respect to that shown in Fig. 3, excepting that low-pressure air of one pound pressure is used to pick up the stream of coal delivered to the burner by the feeding device.

Fig. 5 illustrates a siphon type feeder and burner. By reference to the drawing it will be noted that the coal is siphoned from the hopper into the burner and discharged at high pressure into the furnace.

Fig. 6 illustrates another form of siphon type feeder and burner. By reference to the drawing it will be noted that a siphon is placed in the coal hopper, discharging a mixture of coal and air into the burner, and the siphon in the nozzle of the burner discharges the mixture at high velocity into the furnace.

Feeders and burners of the high-pressure type produce a long flame through progressive combustion and can be used only where the form of the furnace and the character of the work demand that an elongated cutting flame be developed in close proximity to the work done. This method of application is adapted to open hearth furnace practice, and ore nodulizing.

In the type of burners described it is interesting to note that the results obtained in the combustion of fuel are equally good whether the powdered coal is injected into the furnace from the burner at a velocity of 1,500 feet per minute or of 25,000 feet per minute.

Figures given out recently by the U. S. Geological Survey show that the railroads of the United States last year consumed 24 per cent. of the country's total coal production.

NOVEL EMPLOYMENT OF PNEUMATIC AUGERS

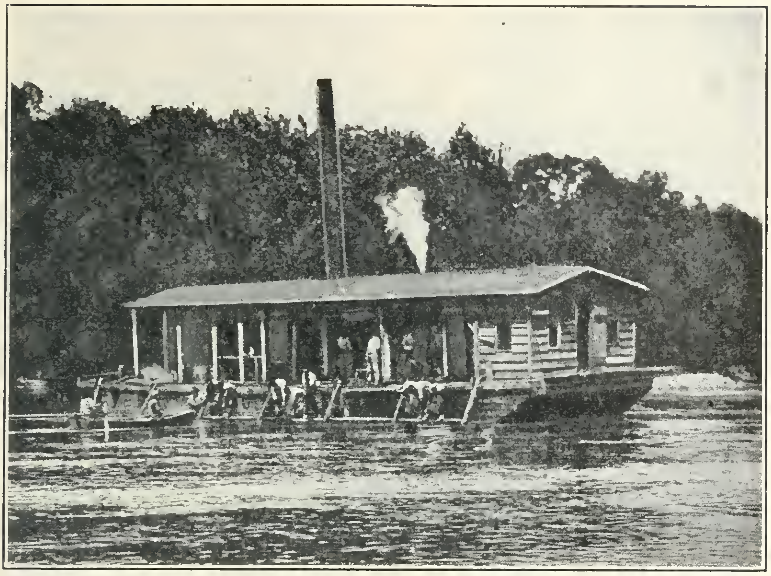
In **Professional Memoirs** of the Corps of Engineers of the United States Army an interesting account is given of improvement operations at Rainwater Bar on the Tombigbee River, Alabama, for the canalization of the river. The channel as located at this point required a dredged cut more than 800 feet long and 100 feet wide through a face of soft shale from 4 to 5 feet above grade.

It was believed that a derrick boat equipped with an orange-peel bucket could not successfully attack the shale, but, nevertheless, this method was tried as an experiment and proved unsuccessful. A powerful dipper dredge was considered for the work, but as it was not available the matter resolved itself into a job of subaqueous drilling and blasting. Here, again, the choice of plant became a matter of consideration, as the material was considered unsuitable for the successful operation of the steam drill.

It was finally decided to experiment with pneumatic wood boring machines equipped with suitable ship augers. Accordingly, a derrick boat equipped with a boiler, air compressor, and an outfit of pneumatic tools, all of which were on hand and formed one of the units of the construction plant used in constructing the 500-foot dam at Lock 3, was sent for trial to Rainwater Bar. The trial proved this method successful beyond expectation, and thus solved the question of drilling. An outfit from plant on hand was then prepared for systematic operation.

The drill boat consisted of a barge 22 feet wide and 64 feet long on which was mounted a boiler, two small air compressors and three pneumatic wood boring tools, with the necessary accessories. Two-inch ship augers were used for the borings. The drilling or boring was done from a platform built along the side of the barge just above the water line. The barge was located by means of ranges on shore and held in position by anchor and shore lines.

In drilling, two to three machines were employed, each being able to average 125 linear feet per day of eight hours with one driller and one helper for each machine. The holes were spaced 5 feet apart and varied from 3 to 9 feet deep in the shale, the average being

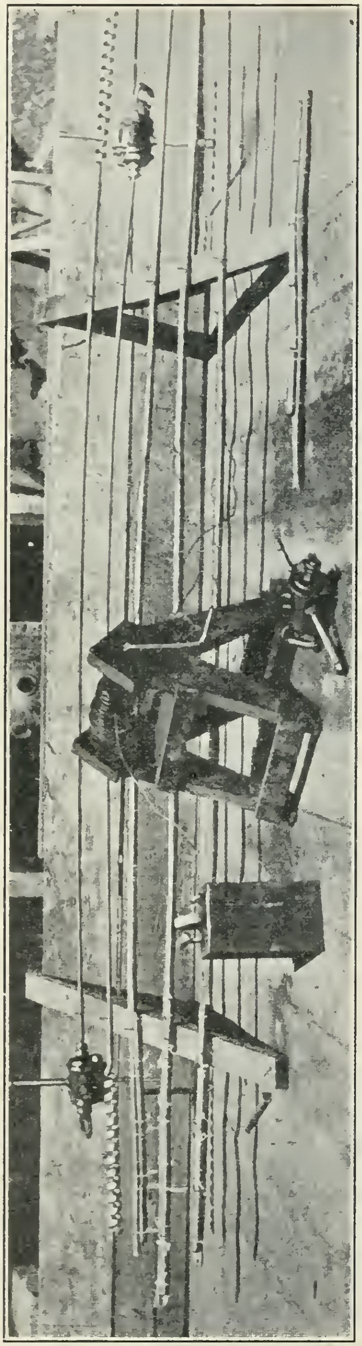


THE DRILL BOAT AT RAINWATER BAR.

about 5 feet. As the holes were completed they were cleaned with an air jet and marked until blasted by inserting in each hole a stalk of wild corn (a plant locally abundant), the top projecting above the water surface.

After a block of holes (varying in number according to circumstances) had been completed the holes were loaded, the barge moved a short distance for safety, and the dynamite exploded by a magneto blasting machine operated from the barge. The explosive used was 40 per cent. dynamite, of which about 2 pounds was required for each cubic yard of material. Usually from six to eighteen charges were

TWO DERRICK BOATS AT RAINWATER BAR.



PNEUMATIC AUGERS FOR SUBAQUEOUS BORING.

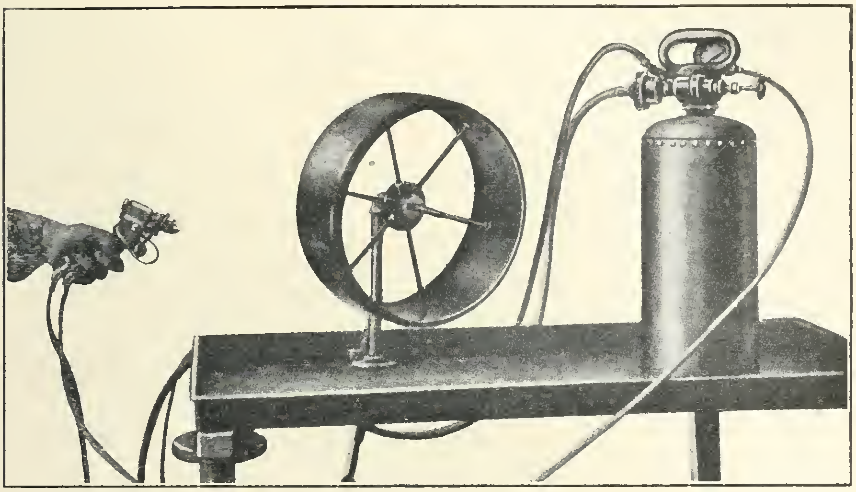
exploded simultaneously. To place the explosive, long stalks of wild cane were used. One side of these was cut away, at the butt, for the length of the charge. In this the dynamite was substituted for the portion of the cane cut away and was attached by wrapping twine. The lead wires of the detonator were carried to the top of the cane, where they also were tied. The cams holding the explosive were then substituted for those previously used for marking the holes. Connections in series were made in the usual manner and the dynamite was exploded.

Over the left half of the area to be drilled the top of the shale was free from any overlying material, but on the right toward the middle of the stream it was overlaid by considerable sand and gravel, which was removed by a derrick boat equipped with a one yard clam shell before the holes were drilled in the shale.

Removal of the blasted material and of the sand and gravel proceeded simultaneously with the drilling. As the interests of navigation required a channel of the full project depth at the earliest practical date the immediate demands of commerce were met by dredging first a channel 50 ft. wide the entire length of the bar.

For the excavation, two derrick boats with booms, respectively 65 and 70 feet long, were used. A 21-cubic foot orange-peel was used for removing the blasted material, and a one yard clam-shell for removing the sand and gravel, rehandling material, and for cleaning up at the completion of the work. The major part of the excavated material was placed in form of a dike along the left side of cut and parallel to it, the top of the shoal at this site being at about what had been the low-water surface before canalization. The material excavated for the 50-foot cut adjacent to the dike was deposited with one cast of the derrick without any rehandling. For the remainder of the material blasted two derrick boats were used with a barge lashed between them, one excavating the material and placing it on the barge while the other, with a clam-shell, rehandled it from the barge to the dike. The sand and gravel overlying the clay was deposited at the right side of the dredged cut and was afterward, with one rehandling, cast along the right bank of the river.

A novel use of the phonograph is made in weighing machines for speaking the weight. The weight is announced in a sonorous voice: "One hundred-and-fifty;" "two hundred-and-three," etc.



THE SPRACO PAINT GUN

The half tone on this page shows the Spraco paint gun in the act of painting a pulley, except that the actual jet of paint is not visible. This outfit, manufactured by the Spray Engineering Company, 93 Federal Street, Boston, is for general use for applying, with the aid of compressed air, all kinds of liquid protecting coatings to various classes of work. It is adapted for use in the shop or factory or wherever a supply of air at the ordinary working pressures is obtainable, and it may be adjusted for spraying the higher grades of varnish or lacquer as well as heavy aspholtum and structural paints, giving uniformly covered and finely finished unstreaked surfaces in all cases.

The complete equipment consists of the paint gun connected by hose to a portable apparatus comprising the paint tank, air dryer and strainer, pressure control attachment and pressure gage, all furnished as a complete unit. The pressure gage shows the air pressure on the main supply line and also on the paint in the tank. By means of the adjustable reducing valve the pressure on the paint may be varied at will so that the action of the gun is made independent of the position of the tank and any grade of paint or other material may be fed to the gun at the most suitable pressure. A complete air strainer and filter insures a constant supply of dry, clean air, and this filter may be readily inspected and cleaned without the use of tools.

There are but two adjustments required in operating the "Spraco" gun, i. e., the round cap at the nose which screws out or in to regulate the amount of paint delivered by the gun, and the knurled stem at the rear which screws out or in to control the amount of air that is used. These adjustments only have to be made once to regulate the proportion of air and paint required for any class of work; then the control trigger acts on both the air and paint, regulating the amount of paint delivered from zero up to the full amount for which the adjustment has been set.

A filling plug in the base of the pressure tank permits the filling or emptying of it without disturbing the control head. Connection with the compressed air system is made by a rubber hose provided with a heavy braid covering, while a flexible metallic hose is commonly used for delivering the paint supply to the gun.

For shop use the control head and pressure regulator are non-essential, unless very heavy paint is being used; and under such conditions the gun may be connected directly to the air pressure line, using an air regulator if the supply pressure is excessive or if the air is not dry and clean. The paint is placed in a tank suspended above the work and is supplied to the gun by gravity. A suitable paint tank with block and tackle for suspension can be furnished with the gun if so desired. The air regulator may be supplied with a filter, pressure gage and reducing valve, providing a complete air controlling apparatus in a single unit.

NEW CAR FOR FISH DISTRIBUTION

A new car for the Bureau of Fisheries, designed for carrying live fishes long distances, has lately been completed and is receiving its special equipment preparatory to being placed in commission. The car is entirely of steel and is thoroughly insulated by the latest improved method to insure against heat and cold. It has a length of 60 feet ½ inch over ends of body plates, and a standard width of 10 feet. The weight of the car with equipment is 150,000 pounds, and is designed to carry a load of 35,000 pounds. In the centre, running lengthwise on each side, are insulated tanks with a total capacity for 130 ten-gallon cans in which fish are held. During transportation the fish will be furnished with oxygen and fresh water by means of air- and water-pumps, operated by a 6-horse-power steam boiler. The boiler will also furnish heat to the car, but, in addition to this independent heating system, the usual train attachment for heating from the locomotive is provided. Tanks for carrying a reserve water supply are located beneath the car, and an ice-box having a capacity of one ton is provided. In addition to the facilities for the transportation of fish, the car is fitted with living accommodations for a crew of five men, a cook's galley, an office, and a space for a dining table.

Fish are distributed by the Bureau of Fisheries in every State of the Union, some 10,000 individual applications being filled annually in addition to the large public plants of the so-called commercial species in the Great Lakes and coastal streams of the seaboards. This phase of the bureau's work has grown to enormous proportions, and in the fiscal year ended June 30, 1915, 49 species were propagated, these including, in addition to fishes, the lobster and several species of fresh-water mussels. The total output of these was over four and a half billions, which were planted in every State and in Alaska. Some idea of the magnitude of the work of distributing fish is indicated by the fact that it involved 637,716 miles of travel, of which 146,544 was by the bureau's special cars and the remainder of car messengers.

BLACK DAMP

The Bureau of Mines, Department of the Interior, in pursuing investigations looking to greater safety in mining, has analyzed samples of the air in many different coal mines in the United States, and has studied the analyses. The results of one phase of this study are presented in Bulletin 105, "Black Damp in Mines," by G. A. Burrell, I. W. Robertson, and G. G. Oberfell. This study shows how atmospheric air, after entering a coal mine, loses oxygen and gains carbon dioxide with resulting formation of so-called black damp. The report also discusses the effects of the constituents of black damp on men, on the burning of oil and acetylene lamps, and on the explosibility of methane.

The authors state that the term black damp was and still is widely used to designate accumulations of carbon dioxide, but a more exact definition of black damp, as Haldane, the English physiologist, has pointed out, is an accumulation of carbon dioxide and nitrogen in proportions larger than those found in atmospheric air. The authors prefer Haldane's definition.

The bulletin treats on the comparison of atmospheric air with mine air, effects on man of variations in composition and amount of air, the effect of temperature and moisture on man, the action of oxygen in coal, the influence of moisture on rate of absorption of oxygen by coal, the effect of lowering oxygen and raising carbon dioxide content on explosibility of methane-air mixtures, and the consumption of oxygen and production of carbon dioxide by men and by lights.

Copies of this bulletin may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

DRILL SICKNESS

A taciturn Hungarian drill runner, cordially disliked by the other miners, was given a one-man drill and a heading to himself by the discerning boss. But even there he could not escape the results of his unpopularity. One day some bright mind conceived the idea of filling the oil chamber on the Hun's drill with oil of asafetida while the Hun was bringing in a stull. Thereupon starting up his drill the asafetida quickly contaminated the drill exhaust, filling the heading with staggering fumes of rotten eggs. Presently the foreman on his morning round met the Hun on his way to the shaft with the drill on his shoulder. "Well, what's the matter with you now?" he growled, eyeing the drill sharply. "D—— drill sick," was the reply, "somebody give him poison."

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE
Compressed Air Magazine Company
Easton, Pa.
New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. OCTOBER, 1916. No. 10

CONTENTS

How the Windows were Broken 8131
Shanking Drill Steels 8133
The Sand Blast in the Foundry........ 8136
Feeders and Burners for Powdered Coal 8144
Novel Employment of Pneumatic Augers 8148
New Car for Fish Distribution......... 8152
Black Damp 8152
Drill Sickness 8152
Humanizing the Societies 8153
Steam Power—New Book 8154
First Aid in Gas Poisoning............. 8154
Sand Blasting and Painting a Large Steel Water Tank 8155
Sand Blasting Material 8156
Air Shocks that Kill 8156
Foam Blankets for Oil Fires........... 8156
A Human Air Pump.................... 8157
Notes 8157
Patents 8159

HUMANIZING THE SOCIETIES

We take pleasure in reprinting here some editorial comment by the genial editor of *Engineering Record* expressing high appreciation, which we heartily endorse, of the admirable work of the editor of the Monthly *Journal* of the American Society of Mechincal Engineers. The Journal, month after month is an admirable piece of work representing a great amount of actual painstaking and persistent effort guided by good judgment and tinctured with the genuine sympathetic spirit, the result being a model which it would be well for the other societies to follow.

It will be noted that the editorial comment below suggests that there should be some touch of youth in the editing of society publications. The age of the editor of the Journal would seem to be just about right, although he is old enough to have been an earlier editor of *Machinery* and substantially helped that publication along to the attainment of the high position which it now holds. Mr. Lester G. French, of whom we speak, not long ago underwent a severe surgical operation, but we are happily informed that he has entirely recovered and is fully on the job again. The editor of *Engineering Record* discourses as follows:

"Engineering societies are giving much attention at present to their publications. In general they are very prosaic documents. There are brief, lifeless minutes of meetings, a formal announcement of future programs, various official notices and then the text of papers which have been presented at recent meetings. The human touch is lacking. One looks through them from a sense of duty. Their advent never receives a warm welcome. Here and there a journal is breaking away from the 'cut and dried' model—which only shows that a human document can be produced from the data available in technical societies. The difficulty lies in a slavish following of custom and in trusting the proceedings solely to a secretary or other officer who has passed the springtime of life and to whom no new event is novel. Publicity is the young man's field. He sees the novel side of each new happening. He glows over incidents toward which the older man is cold. He grows enthusiastic where the other is conservative. He probably has not the maturity and judgment to qualify him to edit professional papers. On the other hand, the staid editor will lack that human sympathy which is necessary to make a journal that appeals to its readers. Most societies could to advantage supplement their editor with a young assistant whose business it would be to put the human touch into their publications.

"The August *Journal* of the American Society of Mechanical Engineers is a happy example of what can be done. First there are the papers presented at meetings of the society. (And be it noted that those deemed of lesser importance are published in abstract, not in full.) Then follows the 'society affairs' section. There is running comment on past and coming meetings. It is easy to read—in marked contrast with the usual minutes and programs. A two-column article tells about the decision of the American Society of Civil Engineers to move to the Engineering Societies Building. Its very title is a welcome to the civil engineers, while the text shows much enthusiasm over the coming of the senior body. Short paragraphs on various matters of society interest then lead to a long—and be it noted, illustrated—biography of Ambrose Swasey, who established the Engineering Foundation. The reports from sections are letters, not minutes, each one a little human document telling of the triumphs, the plans, and the hopes of the sections reporting. They are interesting and inspiring. And so the *Journal* runs. Even its necrology is devoid of the formality that usually hedges in society proceedings. No one needs to be told that the editors of the *Journal* have initiative and the milk of human kindness. Their work is sufficient evidence."

The coming of the American Society of Civil Engineers into the home of the engineering family is an event of great importance which will no doubt be properly celebrated. To provide sufficient space three additional stories are to be added to the building. This magnificent structure, the monument of the surpassing beneficence of Andrew Carnegie, we cannot but think, will still have something lacking, but whether addition of more space would fill the want may well be doubted. Engineers of all the societies have had a feeling, which does not grow less acute, that nothing but strictest business is provided for in the daily routine and that there is nothing except a business need to call any one there, either an engineer visiting the city or a resident engineer with a little leisure on his hands.

For this state of things there is not the slightest suggestion that any one is consciously at fault, but still something should be done, if it can be done, to give the home touch, to make the house a place to which engineers will come instinctively to meet friends, to enjoy little chats and indulge in the free and easy. In some part of it should be a lounging place, if not possibly a loafing place, and if something procurable to eat and drink would help things along, there should be engineers enough to make it work.

NEW BOOKS

Steam Power, by C. F. Hirschfeld, M. M. E. and T. C. Ulbricht, M. E., M. M. E., 428 pages, 5¼ by 7¾ in., 232 cuts, numerous tables. Price $2.00, net.

This is a recent addition to the Wiley Technical Series for Vocational and Industrial Schools. It is a good text book for scholars of the grade indicated and is also adapted for self instruction. It deals with the stationary engine, including the turbine, with no attempt to cover either the locomotive or the marine engine. Boilers and their appurtenances, fuel, combustion, feed water, etc., are also clearly treated. The book is copiously indexed.

FIRST AID IN GAS POISONING

Dr. L. G. Irvine in The Medical Journal of South Africa, writes about "Accidents from Poisonous Asphyxiating Gases in Mines. "He says that in all cases of gas poisoning prompt and efficient first-aid treatment is of first importance. Several of those attempting rescue working with misdirected heroism, have in the past lost their lives, and many more have been temporarily overcome, through ignorance or heedlessness of the risks they have run, or sometimes from lack of the provision of adequate means of local ventilation.

The following points are to be remembered in attempting rescue:

1.—When a gassing accident happens the first thing to do is at once to turn on compressed-air into the place in which it has occurred, and to keep it turned on throughout. This at once supplies those overcome with purer air, and makes it safer for rescuers to enter the danger zone. It seems an obvious precaution to take, but neglect to do so has not infrequently resulted in disaster to those attempting rescue, and in fatal delay in extracting those already overcome. No one should enter the danger zone until it has been well blown out for several minutes.

2.—No man must enter the danger zone alone. Loss of life has occurred from this. Four men are the proper number to form a rescue party, so that if one is disabled the others may be able to help him. Men who have already been engaged in rescue work should not enter the danger zone a second time if fresh men are available.

3.—Rescuers should carry with them one or two candles to test the air, and also electric lamps, or, failing these, acetylene lamps. Never take it for granted that the air is safe because candles continue to burn, but always regard it as an urgent danger signal if candles burn low or go out. If this happens rescuers should at once withdraw and wait until the place has been more thoroughly blown out, unless rescue can be effected immediately and easily.

4.—The next thing to do is to bring the affected man as quickly as possible to the nearest place where the air is fresh, and then at once to attend to the breathing. To bring the man to the surface before commencing treatment will, in bad cases, give that treatment little chance of success, and in cases where artificial respiration is required the delay will render treatment hopeless. Yet this sort of thing still happens.

The routine first-aid treatment recommended is as follows:

a.—In slight cases, where the man is conscious and able to swallow, the usual treatment is to give a dose of emetic—copper or zinc sulphate is commonly employed—and when that has acted to follow with a dose of sal volatile.

This procedure is to be adopted both in cases of carbon monoxide poisoning and of suspected nitrous fumes poisoning, the object being that the act of vomiting will help to express mucus and gas from the lungs. There is no doubt that effectual vomiting gives great relief, and is a valuable safeguard against after effects, particularly in nitrous fumes poisoning.

b.—In all cases of carbon monoxide poisoning of any severity oxygen should be administered.

c.—When the man is unconscious oxygen should invariably be given, and persevered with until consciousness is restored. When breathing is obviously failing artificial respiration must be employed as well. Either Sylvester's or Schafer's method may be used. The former is commonly more convenient on the wet and uneven surfaces of mine floor, but the latter is more effectual, and should be used when circumstances permit.

In desperate cases when breathing has ceased, the use of artificial respiration may sometimes be possible on the spot where the man is first found, provided that the place has first been well blown out. To do so requires courage and judgment, but it has saved life in at least one case within my knowledge.

d.—The man must be kept warm throughout by extra covering, friction of the limbs, etc. He must not be allowed to exert himself too soon, since the carbon monoxide poisoning exertion may readily cause a dangerous exaggeration of the condition. On no account, even in comparatively slight cases, should the affected man be allowed to walk home. Hot coffee should be given, and alcohol should be avoided.

e.—All cases of carbon monoxide poisoning of any severity should be sent to the hospital, and this rule should invariably be followed where the circumstances suggest that nitrous fumes poisoning may have occurred. It is most important to keep these cases under observation, since the danger of acute symptoms setting in after apparent temporary recovery is always present. The medical attendant of the patient should be notified in all cases of gassing, particularly when poisoning by fumes is suspected.

SAND BLASTING AND PAINTING A LARGE STEEL WATER TANK

A new steel tank 100 ft. in diameter, 44 ft. high and holding 2,500,000 gallons, for the high service portion of the system of the Metropolitan Water District of Massachusetts, has recently been painted all over having been in service about two months. Immediately preceding the painting operation in detail the surface was thoroughly sandblasted for the removal of rust and to secure perfect contact of the paint with the metal.

The plant used consisted at first of a 20-h. p., gasoline engine driven air compressor, a compressed air reservoir, two lines of air hose and two nozzles. Sand blasting was stopped in the latter part of the afternoon of each day and the cleaned surfaces were painted before rusting commenced. The force employed included 1 foreman, 2 painters, who also did sand blasting, and 1 helper. This force could sand blast and paint an area of about 330 sq. ft. per day. Later, in order to increase the rate of progress, a second compressor, operated by an automobile engine, was installed.

The entire inside and outside surface of the tank, having an area of 35,650 sq. ft., was sand blasted and painted. Work was begun on March 30 and was completed June 14, with the exception of the third coat on the outside, which has been deferred until after the masonry tower which encloses the tank is completed. All painting materials were furnished by the department, but were mixed by the contractor, W. L. Maples Co., Boston, under the direction of the engineer. For the inside of the tank National Lead Co.'s red lead in oil paste, litharge and Spencer-Kellogg & Son's boiled linseed oil were used; the first coat natural color, the second and third coats tinted with lamp black in oil. For the outside of the tank red lead paste, raw linseed oil and drier were used for the first coat, and for the second coat white lead, raw linseed oil, turpentine and drier tinted with lamp black were used. One gallon of red lead paint was sufficient to cover 700 sq. ft. of surface with one coat. The sub-contractor's price for sand blasting and painting the tank was $1,600.—*Engineering and Contracting.*

SAND BLASTING MATERIAL

A recent inquiry addressed to a number of manufacturers and large users of sand blast apparatus brought out the fact that shot or grit mixed with the sand is not desirable, because one is already round and the other will have the sharp corners rounded off very quickly, thus giving the effect of hitting the casting with a dull tool. One user of this type of machinery employs sand that will pass through a No. 10 mesh sieve, while one builder recommends that heavy grain sand only be used as a general rule, unless a fine finish is desired, in which case fine sand can be mixed in.

The location of the plant is a factor in determining the kind of sand that is used. Cape May sand, which can be obtained in different grades, is generally employed in the East, while in the Middle West very fine silica sand is employed with equally good results. Another user brings out the point that various types of machines require different grades of sand, a steel grit being used to better advantage with some machines than the sand, while in others it is out of the question to use the grit at all.

AIR SHOCKS THAT KILL.

Air shocks from the explosion of shells have killed men in the trenches on European battlefields. It was noticed after artillery battles that many bodies bore no apparent wounds, and evidently death had come from instantaneous stoppage of the circulation. According to La Nature of Paris, the explosion of a high-power shell causes a considerable barometric depression equivalent to the exhausted atmosphere at the top of Mount Blanc, 15,000-ft. altitude. A sudden barometric depression, similar to the experience of an aeronaut who descends too rapidly, separates from the blood the air and carbonic-acid gas normally held in solution, and these bubbles become caught in the capillaries and stop the flow of blood instantly. Death occurs from 'gaseous embolism.' This is similar to the form of paralysis, known as the 'bends,' that afflicts miners or 'sand-hogs' working in compressed-air caissons, when, on coming out, they do not remain in the reducing-chamber long enough.

FOAM BLANKETS FOR OIL FIRES

In the protection of its oil tanks against conflagration the Standard Oil Company of California has met this requirement by developing a liquid extinguisher, which it calls "fire foam." Fire foam is formed by two separate liquors which, when mixed together, result in a thick spume, which readily spreads over a wide area and effectively shuts off the oxygen supply of the burning oil. The two liquids must be separately stored and brought together only just prior to the time when the foam blanket is desired in the blazing tank. The fire-foam liquors are led through a mixing pipe and discharged through tee heads above the surface of the oil at the centre of the tank, issuing from the outlets in the form of a thick liquid of creamy appearance. The foam rapidly spreads out over the surface of the blazing oil, bubbling as would a huge caldron of dense, boiling liquid. Here and there the flames are seen to reduce in size, eventually to be smothered entirely as the foam blanket becomes more dense. In the period of about a minute the fire is completely extinguished.

A HUMAN AIR PUMP

A boy thirteen years old was run over recently by an automobile in New York City. He had four ribs broken and these punctured the lungs. Soon after the boy reached the hospital it was apparent that he was able to inhale normally, but in exhaling the air passed from the lungs into the subcutaneous tissues. This air spread and accumulated under the skin all over his body and head. The body became twice his normal size, his chin and chest touched and his skin was stretched almost as tight as the head of a drum. Surgeons throughout the city soon heard of the rare case, known as emphysema, and many of them went to the hospital to observe and study it. An operation was performed and it was believed that the boy's life would be saved.

NOTES.

Armour plate 16-in. thick was recently cut by an oxygen torch at the rate of 4 linear inches per minute, or more than one sq. in. of surface per second. A gun port in an 18-in. armour plate was cut in 50 minutes that would ordinarily have required four weeks of drilling and two weeks of machining time. In 5-in. armour plate a cut of 52 linear ft. and a bevel of 48 linear ft. were cut in two hours and seven minutes, at a cost of $54.38 for gas, compared with machine drilling which would have required four weeks and cost about $2,000. The work was done with mechanically-guided torches using hydrogen as the fuel gas.

Cutting off piles in the dry below water level was recently effected by means of a movable cofferdam of a riveted steel cylinder 6 ft. diameter and 10 ft. long which was lowered around the pile to rest on the bottom of the river. The cylinder was sealed by sand and gravel deposited outside and was unwatered by a pulsometer. Men then entered the cylinder and cut the pile at the exact elevation with an ordinary cross cut saw. The cylinder was easily shifted from pile to pile, and thus obviated the use of the floating pile driver with a submerged circular saw mounted on a vertical shaft such as is ordinarily used on construction work.

A limestone quarry which is about a mile long, picturesque in appearance and dangerous to work in, is located near Rockland, Me. There 305 laborers, chiefly foreigners, toil in chasms having perpendicular sides 500 feet high, and no way of entrance or egress except by means of the derricks which hoist and lower about a dozen men at a time. Approximately 1,000,000 barrels of lime are prepared in the vicinity of Rockland annually.

The rats which swarm the fighting trenches of France are not an unmitigated evil. They are not uncleanly and living men are seldom or never bitten by them. They are, as we know from mining experience, very susceptible to the effects of deadly gases, and when they show signs of distress from this cause the soldiers at once put on their gas helmets.

Much has been said of the cost of building the Panama canal, but during the period of its building the Bell telephone interests spent twice that amount in extensions and renewals in the United States. Because the money was spent in 70,000 communities by a private company it attracted much less attention than the dramatic work of the American government on the Isthmus.

From recent investigations made aboard the ice-patrol, coast-guard cutter Seneca it was determined that a cubic yard of fog at sea contains about 0.02 of an ounce of moisture. It was also found that the particles of moisture measure about .0002 inch in diameter. The average number of persistent nuclei in a cubic inch of fog was estimated at 16,000; numerous tests failed to reveal less than 6,500 in that amount of space, and on the other hand the number sometimes was as high as 800,000.

The highest habitation in the world is stated to be in Peru. Professor Isaiah Bowman reports that he crossed the Andes by the passes between Antabamba and Cotahuasi, and at 17,100 ft. altitude saw a thatched stone hut that sheltered a family of five. These natives were apparently quite healthy, and "three rosy-cheeked children almost as fat as the sheep about them were playing with balis f wool." The atmospheric pressure at the altitude mentioned would be only one-half that at sea level.

At Butte, Montana, recently by a combination of sinking and raising, a system increasing in popularity, an average of 250 feet per month was sunk in hard granite. The usual rate of direct sinking at Butte is 100 ft. monthly, timbering at the same time. At the Chief Consolidated mine at Tintic, Utah, a shaft 6 by 15 feet in the clear was sunk 256.3 feet in a month. For 150 feet the formation was hard porphyry, the remainder limestone. This is considered to be much above any previous record.

One of the minor directions [very minor, we would say] in which mechanical engineers can help the war is by collecting all their old cloth tracings or unused tracing cloth and sending it to Lieut. R. D. T. Jones, R. E., Ministry of Munitions, Storey's-gate, Westminster. The cloth when boiled, washed and sterilized makes excellent bandages, pillow cases, etc., for the wounded—things that are still badly needed. Engineers need have no fear that their designs will be copied, because all the tracings are handed to a responsible person to be treated.—*The Engineer, London.*

Oil Output of the World in 1915 totaled 426,892,673 bbl., equal to 57,298,786 metric tons. The United States contributed 65.85%; Russia, 16.06%; Mexico, 7.71%; Dutch East Indies, 2.9%; Roumania, 2.82%; India, 1.73%; and Galacia, 0.98%. The 1915 yield was an increase of 7%.

A special arrangement has been devised to give a more realistic effect when a gun is fired in the movies. A thin metallic cartridge is provided charged with air at a very high pressure and in front of this cartridge is inserted a certain quantity of talcum powder. The cartridge is punctured by pulling the trigger, this releasing the air which drives out the talcum powder with a photographic effect much superior to any that can be secured from the smoke of ordinary powder. The instant of the "firing" of the gun is thus clearly indicated, which is often very essential to the action of the scene.

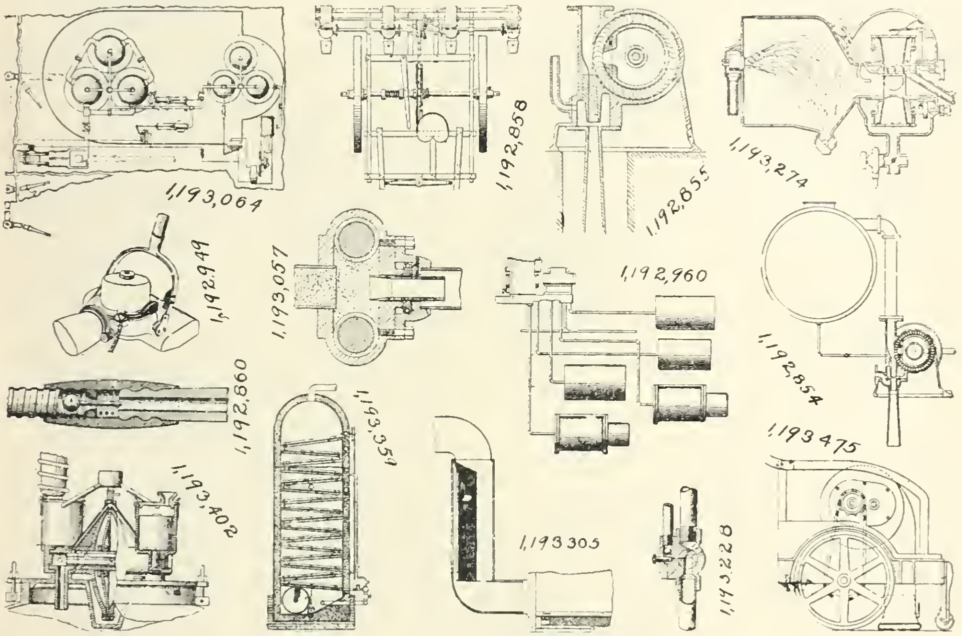
A pump in the Butte & Zenith mine, Montana, was under 275 ft. of water. It was of the duplex-sinker type and was in a horizontal position. Compressed air was turned into the pipe-line, and the pump started almost immediately although it had been idle for 15 months. It ran until the water was lowered 65 ft., when trouble arose in the air-compressor. After the compressor had been repaired, the pump could not be started again, until superintendent Gibson turned 100 lb. of pressure on the air-column, with the pressure released on the water-column, forcing the plunger back. The pump started again and was kept in continuous operation until the shaft was unwatered.

The dangerous gas CO (carbon monoxide) should not result from the explosion of a modern high explosive. The results of blasting should be CO_2 (carbon dioxide) and H_2O, providing the explosive is properly compounded and detonated. It has been said that the carbon contained in the paper wrappers of dynamite sometimes makes CO gas. As little as 0.25% of CO in the air may affect a miner, while 7 or 8% of CO_2 (called 'choke damp') is necessary to cause distress.

Ordinary socks are not worn by German soldiers, it is stated. They use a square cloth somewhat larger than a large napkin, which can be wrapped around the foot in 30 different ways, according as it is desired to protect any particular portion blistered by long marches. This method of encasing the foot for the wear of heavy boots is well known to miners, many of whom prefer the square cloth to socks.

Compressed air is employed by French soldiers in the trenches for throwing bombs. Four men work with bicycle-pumps to make a high pressure of air, and the bomb is shot noiselessly from a piece of pipe improvised as a cannon.

The popularity of electric cooking seems to be extending, even the birds having adopted it. *Edison Current Topics* reports that recently two transmission line short circuits were caused by birds dropping snakes across the bored cables. The snakes were of course rapidly and thoroughly cooked.



Pneumatic Patents August 1.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 1

1,192,854. WET AIR-PUMP. Otto C. Buss, Havre, France.

1,192,855. ROTARY AIR-COMPRESSORS. Otto C. Buss, Havre, France.

1,192,858. MACHINE FOR BLOWING POWDERED POISON ON PLANTS. Patrick Callahan, Stratford, Conn.

1,192,860. COUPLING FOR GAS-HOSE. John J. Carey, Brooklyn, N. Y.

1,192,949. SUCTION-SWEEPER. James M. Spangler, Canton, Ohio.

1,192,960. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,193,057. APPARATUS FOR FEEDING REGULATED QUANTITIES OF FINELY-DIVIDED MATERIAL. Wirt S. Quigley, New York, N. Y.

1,193,064. FIRE-EXTINGUISHING SYSTEM AND APPARATUS. Alva Leman Reynolds, Long Beach, Cal.

1,193,173. PROCESS FOR OBTAINING THE SOLIDS FROM LIQUIDS. Irving S. Merrell and Oliver E. Merrell, Syracuse, N. Y.

1. The process of producing desiccated milk powder which comprises removing a portion of the water contents of the milk by evaporation, atomizing the condensed milk in a chamber, and surrounding the atomized condensed milk with an envelop of forcibly projected air.

1,193,228. HIGH-PRESSURE GAS-LIGHTING SYSTEM. Lindsay Fillan Boyd, Hawksburn, Victoria, Australia.

1. In high pressure gas-lighting systems a gas supply pipe and a compressed air supply pipe leading to separate passages in the body of a three-way cock, a junction between the inner ends of said passages, a screw for adjusting the size of the opening from the passage leading to the gas supply pipe, a third passage in the body of the three-way cock leading from the junction of the first mentioned passages, and a pipe leading from the last mentioned passage to a burner, substantially as described.

1,193,274. APPARATUS FOR FREEING LUMP-STARCH FROM ADHERING DUST OR POWDER. Adolph W. H. Lenders, Cedar Rapids, Iowa.

1,193,305. AIR-PURIFIER FOR LAUNDRY-DRYING MACHINES. Willard G. Slagle, Memphis, Tenn.

1,193,318. PNEUMATIC TOOL. Robert E. Veltum, Eugene, Oreg.

1,193,359. CONTINUOUSLY - OPERATING VACUUM-EVAPORATOR. Joao do Amaral Castro, Sao Paulo, Brazil.

1,193,402. MILKING-MACHINE. Elmyr A. Laughlin, Chicago, Ill.

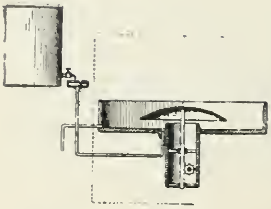
1,193,467. APPARATUS FOR COOLING HEATED AIR BY ELECTRIC CURRENTS. Arthur L. Mills, New York, N. Y.

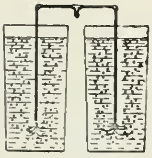
1,193,475. PNEUMATIC BLOWING - MACHINE. Joseph J. Smith, Cambridge, Mass.

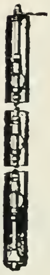
AUGUST 8

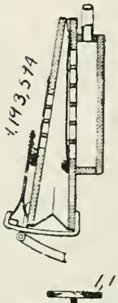
1,193,524. ATOMIZER. Thomas A. De Vilbiss, Toledo, Ohio.

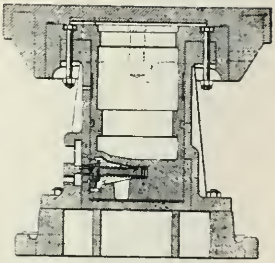
1,193,594. PUMPER - BELLOWS. James O'Connor, New York, N. Y.

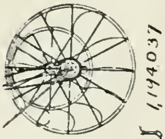


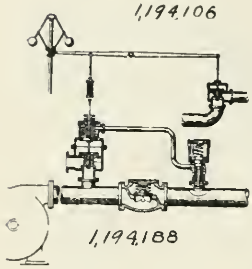


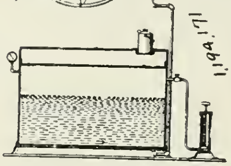


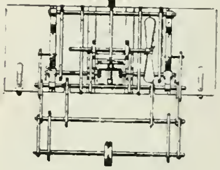


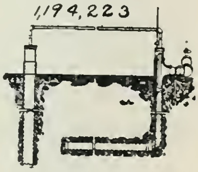












Pneumatic Patents August 8.

1,193,609. PNEUMATIC FLUID-LIFT. James K. Putnam, Tulsa, Okla.

1,193,845. AIR-MOTOR. Maryan Troyanoski, Rockfall, Conn.

1,194,037. AIR - PROPELLER AND THE LIKE. Carl Kropp, Deuben, near Dresden, Germany.

1,194,059. SAND-MOLDING MACHINE. W. C. Norcoss, Terre Haute, Ind.

1,194,106. LIQUID-FUEL BURNER. William A. White and James McDonald, New York N. Y.

1,194,108. WATER - AGITATOR FOR ICE PLANTS. Jewel Bangs Williams, Cincinnati, Ohio.

1,194,171. LIQUID - DISPENSING APPARATUS. Coy E. Hamilton, Elkhart, Tex.

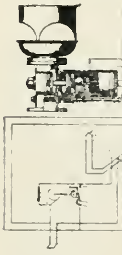
1,194,188. DEVICE TO PREVENT SURGING IN CENTRIFUGAL COMPRESSORS. Walter Kieser, Charllotenburg, Germany.

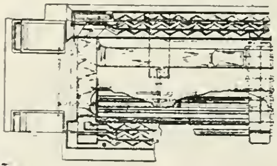
1,194,223. GAS - PURIFYING APPARATUS. Herbert L. Pearce, Nickleville, Pa.

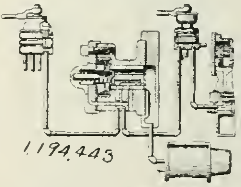
AUGUST 15

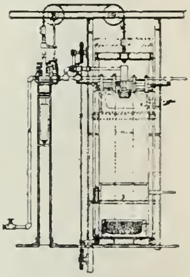
1,194,346. FLUID - ACTUATED MOTOR. George Akans, Atlanta, Ga.

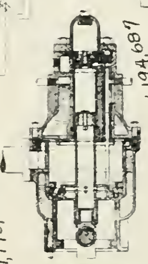
1,194,358. SPRAYING APPARATUS. Robert E. Cecil, Sewickley, and Horace E. Grant, Pittsburgh, Pa.

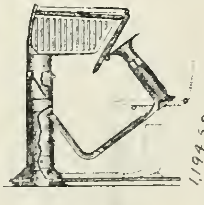


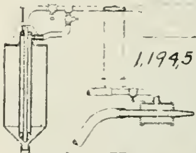


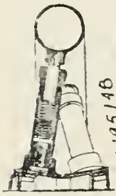


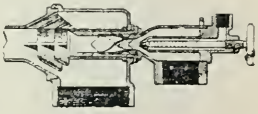


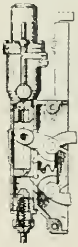


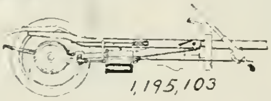


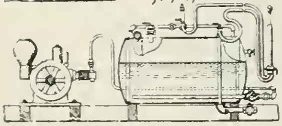


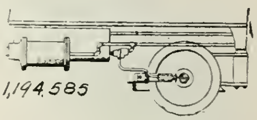


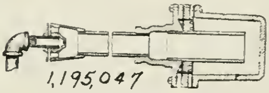












Pneumatic Patents August 15.

1,194,443. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.

1,194,518. COOLING APPARATUS. Henry E. Leavitt and Albert D. Lane, Oakland, Cal.

1,194,520. PROCESS OF LAYING SHEET-GLASS. Harry F. Lewis, Ford City, Pa.

1,194,527. VENTILATING SYSTEM FOR SCHOOL ROOMS. Edward M. McNamara, Chicago, Ill.

1,194,585. AIR-BRAKE. Percy Warner Williams, Ogden, Utah.

1,194,687. MULTISTAGE COMPRESSOR. George Westinghouse, Pittsburgh, Pa.

1,194,740. ATMOSPHERIC BURNER. Campbell Murray Hunter, London, England.

1,194,914. SIGNAL. Frank W. Wood, New York, N. Y.

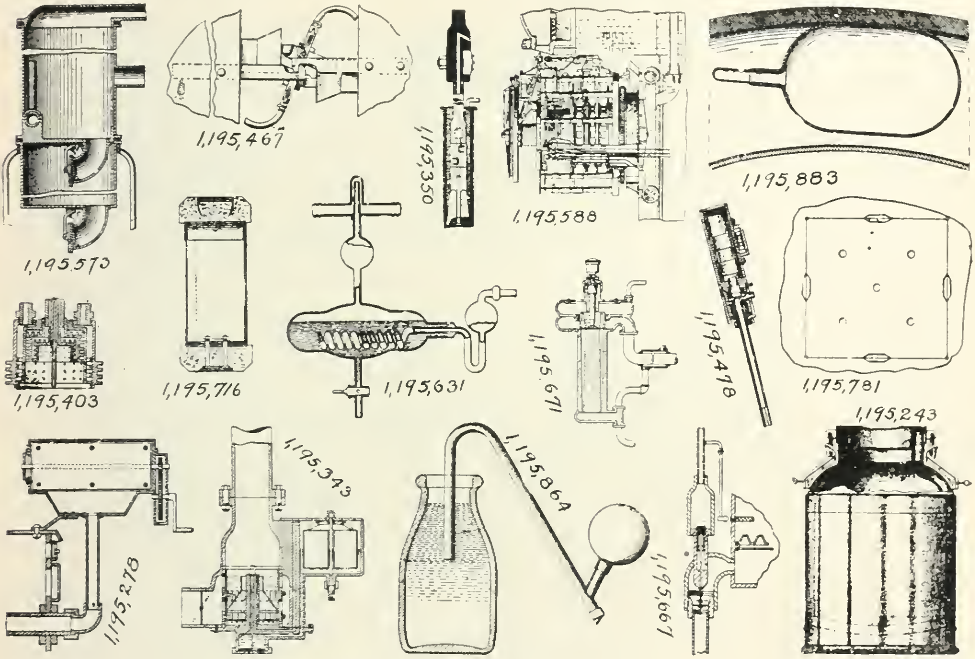
1,195,002. GLASS - BLOWING APPARATUS. Warren D. Gumpp, Arnold, and Fernand M. Francart and George C. Debay, Springdale, Pa.

1. A single burner provided with means for projecting gaseous and mixed fuel in the direction of its axis and additional means for projecting ignited gaseous and mixed fuel toward the first means above mentioned.

1,195,467. AUTOMATIC AIR-BRAKE- COUPLING DEVICE. Emil Sern Hansen and Christian P. Hansen, Anderson, Cal.

1,195,478. ROCK - DRILL. Moses Arthur Knapp, Oakland, Cal.

1. In a rock drilling apparatus having a drilling engine of the hammer type constructed to apply percussional impulses of high frequency and in combination with a hammer and drill bit, a series of separate alined contiguous rods intermediate said hammer and said drill bit, a tube surrounding said rods and engaging said drill bit and and means for rotating said tube and drill bit without subjecting the rods to torsional strain.



Pneumatic Patents August 22.

1,195,047. GAS-BURNER. Charles Ludlow, Norwood, Ohio, and John Keown, Newport, Ky.

1,195,103. AIR-BRAKE. Ray Scoggin, Eugene, Oreg.

1,195,148. PNEUMATIC WHEEL. Walter Thomas Newman, Vancouver, British Columbia, Canada.

AUGUST 22

1,195,243. VACUUM MILK-CAN. St. Vrain Le Sieur, New Athens, Ill.

1,195,278. STOVE-BLOWER. Frank Shadley, Hebron, Ind.

1,195,343. VACUUM-CARBURETER. William John En Earl, Monte Vista, Colo.

1,195,350. PUMP-DRILL. George H. Gilman, Claremont, N. H.

1,195,403. COMPRESSED GAS AND AIR BURNER. Alexander K. Schaap, New York, N. Y.

1,195,573. MILK - RELEASING APPARATUS FOR USE WITH MILKING-MACHINES. Robert Bruce Forsyth, Christchurch, New Zealand.

1,195,588. AIR-CONTROL FOR AUTOMATIC MACHINERY. August Kadow, Toledo, Ohio.

1. The combination with a plurality of superposed horizontally movable air valves, of a valve actuating device, means for causing a relative movement between said valves and said valve actuating device, whereby said valves will be intermittently actuated as required, and means whereby the relation between said valves and said actuating device may be so adjusted that said valves will be actuated at will either simultaneously or successively as required.

1,195,631. APPARATUS FOR INDICATING THE VOLUMETRIC FLOW OF A GAS. Ernest E. Werner, Indianapolis, Ind.

1,195,661. VERTICAL AIR - COMPRESSOR. Kennedy Dougan, Minneapolis, Minn.

1,195,667. AIR AND GAS VALVE. Elmer F. Fisher, Springfield, Mass.

1,195,691. METHOD OF AND APPARATUS FOR COMPRESSING ELASTIC FLUID. JOHN A. LAFORE, Ardmore, Pa.

1. The method of compressing gas, vapor or elastic fluid, which consists in producing a succession of masses of elastic fluid diminishing in velocity and increasing in pressure, and entrapping between and carrying with said masses of elastic fluid masses of gas, vapor or elastic fluid.

1,195,716. PNEUMATIC - DESPATCH - TUBE CARRIER. ALBERT W. PEARSALL, Lowell, Mass.

1,195,781. METHOD OF CHANNELING AND SEVERING BY BLASTING. TERE A. CLARK, Chicago, Ill.

The method of channeling and severing material which consists in forming a plurality of holes along the contour of the object to be severed to limit the cleavage, forming additional holes intermediate to said aforementioned holes to direct the cleavage and exerting an expansive force in said additional holes to sever the object.

1,195,864. SELF-CHARGING SIPHON. WILLIAM P. STARR, Philadelphia, Pa.

1,195,883. LEAK-ALARM FOR PNEUMATIC TIRES. GEORGE W. WELLS, Amesbury, Mass.

AUGUST 29

1,195,983. AIR-STRAINER. CLYDE C. FARMER, Chicago, Ill.

1,195,995-1,196,001. MILKING - MACHINE. MEREDITH LEITCH, Poughkeepsie, N. Y.

1,196,011. ROCK-DRILL. NIELS C. MICKELSON, Denver, Colo.

1,196,041-2. ROCK - DRILLING APPARATUS. WILLIAM A. SMITH, Denver, Colo.

1,196,052. ROTATING MEANS FOR DRILLS. DANIEL S. WAUGH, Denver, Colo.

1,196,055. AIR-COMPRESSOR. HENRY HERMAN WESTINGHOUSE, New York, N. Y.

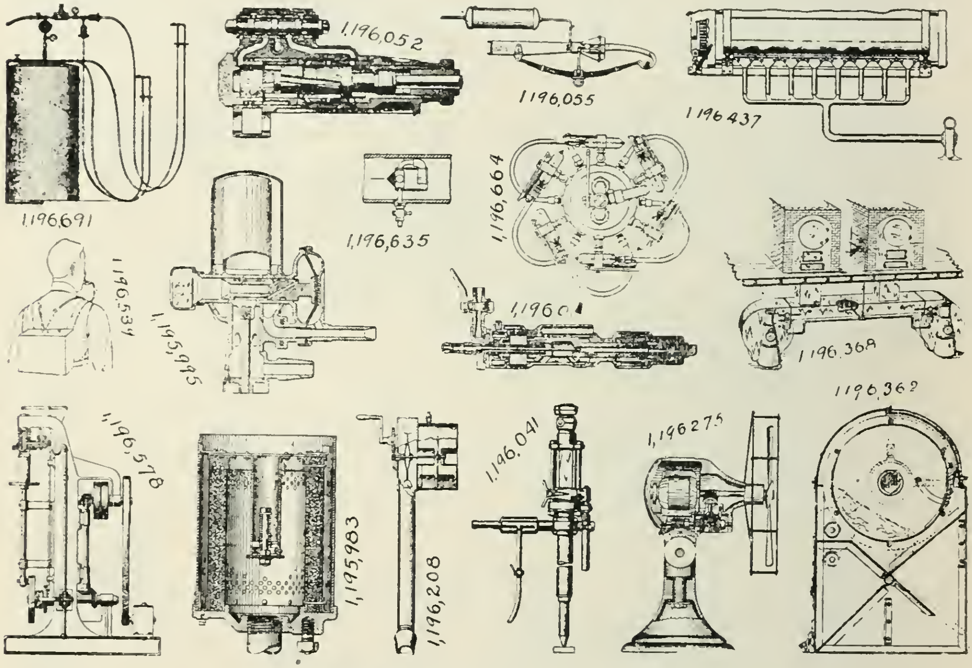
1,196,208. ANIMAL-EXTERMINATOR. IRVING D. CHARLTON and WILLIAM T. SHAW, Pullman, Wash.

1,196,275. AIR-CIRCULATING DEVICE. EDWIN P. PHELPS, Wilmette, Ill.

1,196,362. SAND-BLAST APPARATUS. FOSTER J. HULL, Hagerstown, Md.

1,196,368. AIR-VALVE CONTROL. WILLARD A. KITTS, Jr., New York, N. Y.

1. The method of controlling the speed of an engine driving a plus or minus pressure creating device, consisting in withdrawing a portion of the pressure created from the main body thereof and varying the withdrawn pressure by allowing a regulated communication of the same with the atmosphere, and utilizing said pressure as varied to determine the speed of the pressure creating device.



PNEUMATIC PATENTS AUGUST 29.

1,196,437-40. METHOD OF CONDITIONING PAPER PREPARATORY TO PRINTING THEREON. JAMES E. DOYLE, Cleveland, Ohio.

1,196,518. PNEUMATIC PLAYER - PIANO. JAMES P. CAULFIELD, Baltimore, Md.

1,196,539. AIR-PURIFIER. EDWARD I. GOLDBERG, New York, N. Y.

1,196,578. VACUUM SEALING - MACHINE FOR CONTAINERS. HORATIO N. NORTON, Mount Vernon, N. Y.

1,196,635. UTILIZATION OF COMPRESSED AIR FOR MOTIVE-POWER PURPOSES. BENJAMIN ANGWIN, Camborne, Cornwall, England.

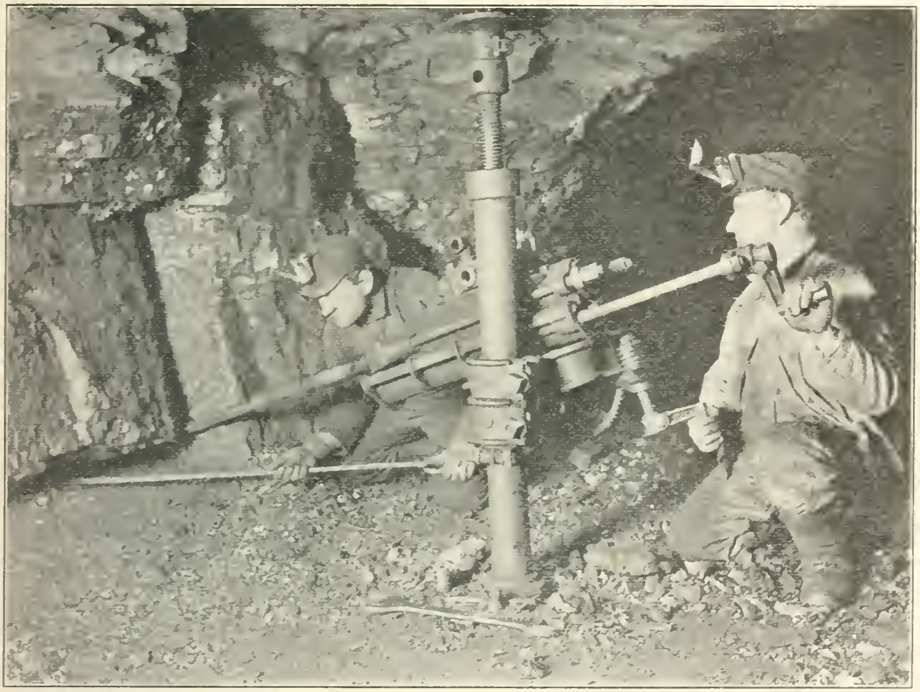
1. The combination with an air-main having a heating chamber, of an oil vaporizer arranged within said chamber, a shield arranged in front of said vaporizer for directing the incoming air around the same, and an oil vapor burner receiving fuel through said vaporizer and the flame from which is adapted to heat said vaporizer.

1,196,664. HUMIDIFYING MEANS. FRANK B. COMINS, Sharon, Mass.

1,196,691. MEANS FOR DISTRIBUTING LIQUIDS. BLAKE F. HOPKINS, San Francisco, Cal.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XXI NOVEMBER, 1916 No. 11



RADIAL PUNCHER AT WORK.

MINING THIN COAL BEDS WITH AIR PUNCHERS

BY S. W. SYMONS

My attention has been called to a published inquiry as to how best to mine thin coal beds. As a partial answer to this it will be proper to show how this is actually done in some of the bituminous mines, where thin beds are worked and where compressed air is employed. A knowledge of some of the methods that have recently come into use for mining anthracite also may prove of interest.

A device frequently employed for thin beds in bituminous mines is the "radial" type of mounted pick machine, with which the readers are more or less familiar. Beds as thin as 2 ft. have been mined successfully in Europe with machines of this type. The general method of mining is to undercut to a depth of 5 or 6 ft., and sometimes, as in the case of bad roof, to overcut the coal. after which it can be broken down in the usual manner, using about 1 hole in every 9 or 10 ft. of face and two to three sticks of explosive in each hole. The number of holes or the amount of powder can be reduced when the coal is overcut, but this is only warranted when the roof is in bad shape, or when by so doing it becomes possible to eliminate timbering.

The radial puncher is made in two styles, one operated by compressed air and the other by electricity. The compressed-air type can be operated from a small portable plant mounted on a mine car. Some of these portable outfits are becoming popular in the anthracite district. The compressed-air machine is lighter and more easily handled than the electric type, though it consumes slightly more power.

It is impossible to make any definite statement as to the coal-cutting capacity of the radial type of puncher, 200 to 300 sq. ft. of cutting per 8-hr. day being considered a fair average for fairly hard coal. But in lignite, in a Canadian mine, with one of the latest types of radial machines, as high as 180 sq. ft. per hr. of actual cutting time has been recorded.

The beds of anthracite coal mentioned above carry a shale parting, which is cut out by the radial puncher. To do this two cuts are required, a bottom and a top cut, after which the intervening portion can readily be broken out. Or, if the material separates freely, a single cut at the bottom will suffice and a hand or pneumatic pick may be employed to bring down the coal. There appear to be no adequate records available of the speed to be expected in shale, but it is doubtful if there is a machine other than the air puncher which could handle it to equal advantage.

This method of mining, besides eliminating the shale and leaving the coal intact, has the effect of reducing the number of shot holes and the amount of powder necessary.

In mining anthracite, and also, to a limited extent, in bituminous operations, the air-driven Jackhamer drill is often employed for boring shot holes. This has been brought about by the ever-increasing demand for greater production. One particular instance is that of the St. Louis, Rocky Mountain and Pacific Co., of Koehler, N. M. In this mine the seam was 40 in. thick with an 8-in. parting 7 in. from the bottom. The parting (material unknown) was cut out with an air puncher, after which, in a 40-ft. room, it was necessary to place four shots in the top and bottom benches to loosen them properly for loading. The coal was hard and contained sulphur bands near the roof, which made drilling difficult.

A Jackhamer drill was installed and resulted in a doubling of the output, increasing the men's wages about 50 per cent. and making an actual saving of 9c. per ton, in addition to that resulting from increased production. Under test, six 4-ft. holes, 14 in. of each hole being through hard sulphur, were drilled in 20 min.—*Coal Age.*

DON'T USE COMPRESSED AIR FOR THE WORK

"Because of hard spots in the stock and unevenness of the circumference in cutting off bar stock, the tool may cut very irregularly as ordinarily fed. Not only that, but the hard spots are severe on the tool. Forcing the cutter into the work by means of a compressed air cylinder obviates both these difficulties. The air is just elastic enough to permit the tool to give a trifle when it strikes a hard spot."

The above we find in a recent issue of *Factory* which offers much good advice upon the details of shop and business management. In this case, however, we cannot agree with it, and much as we believe in compressed air we cannot think it wise to advocate its use for purposes to which it is not adapted. The writer as a latheman of long experience would say that a cutting off tool should have a positive and unyielding feed. If it were allowed as suggested to dodge the hard place the first time around it would have to dodge twice as much the second time around and so on. After a time it would be apt to get tired of this dodging and when the hard spot approached again it would dig in and you would have a broken tool. If at the beginning the circumference was irregular the tool should not cut all the way round but only cut the high spots until they came down to the low spots and then there would be continuous cutting.

An ordinary canvas cover is not a tarpaulin, but a paulin. Five parts coal tar, one part gasolene and our part good japan dryer, makes a good water-tight coating for canvas.

PNEUMATIC TAMPING REDUCES TRACK GANGS

BY H. L. HICKS

The development of the pneumatic tie tamper was the natural outgrowth of a demand for a mechanical device that would reduce the cost of ballasting track. The pneumatic tamper has now been in use for about a year and a half on electric railway work, and from the results obtained it is safe to say that this type of machine has come to stay. Its use is already wide-spread and it is not idle fancy that warrants the prediction that the pneumatic tie tamper will in the course of time practically supersede all hand tamping.

The pneumatic tie tamper, as its name signifies, operates on compressed air. It is a percussive tool similar in action to the pneumatic riveting hammer. The tamper, Fig. 1, consists of a barrel section, containing a free moving piston, a suitable extended handle with grips for holding it and a tamping bar. The last is inserted in the end of the barrel and is loosely held in place by a retainer fitting over a collar on the tamping bar itself. The piston reciprocates rapidly and delivers a succession of blows on the upper end of the tamping bar which in turn transmits the impact to the ballast.

THE TAMPING OPERATION

Pneumatic tie tampers are operated in pairs, Fig. 2, one tamper on each side of a tie. Their weight, 37½ lb. each, is sufficient to feed the tools down as the ballast is forced under the tie. All that is required of the operators is to hold and guide the machines. The tamping bars rest on the ballast and force it down and under the tie. In starting, these tampers are held vertical with the broad faces of the tamping bars parallel with the tie. This position is maintained until the bottom of the tie is reached when they are swung outward until at the proper angle to force the ballast under the center of the tie.

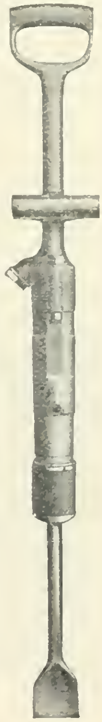


FIG. 1.

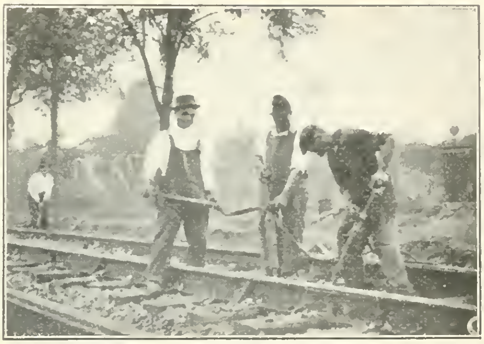


FIG. 2.

In the operation of the pneumatic tamper the tamping bar is practically stationary, transmitting to the ballast the rapid blows received from the piston. The absence of reciprocating motion makes the guidance of the machine an easy matter. The operator is able to avoid striking and injuring the ties and can guide the tamping bar in between switch points, cross-overs and similar places where he could not swing a pick or wield a tamping bar. It has also been a matter of observation that the pneumatic tamper does not crush the ballasting material.

The pneumatic tamper operates most efficiently on air at 65 lb. to 75 lb. pressure. In terminal yards and on systems where electro-pneumatic signals are used it has been found both convenient and entirely practical to use air from the signal service line, as the small amount used does not impair the operation of the signals. In ordinary traction work air is supplied from a portable compressor, usually electric driven. The customary provision of 300 ft. of hose gives a large working radius without moving the compressor.

While the pneumatic tie tamper works in any kind of ballast it is advisable to change the dimensions of the tamping bar face to suit the size of ballast and thus secure maximum effect from the available power. In crushed stone, 2 in. or over in size, a bar with a face 3 in. x ⅝ in. gives best satisfaction; with smaller stone or gravel a tamping face 3 in. x ⅞ in. is most effective and in tamping sand, dirt or cinders a still larger face, 3 in. x 1⅛ in. secures the greatest efficiency.

VARIOUS TAMPING EXPERIENCES

It is interesting to note the experiences of several electric railways with the pneumatic

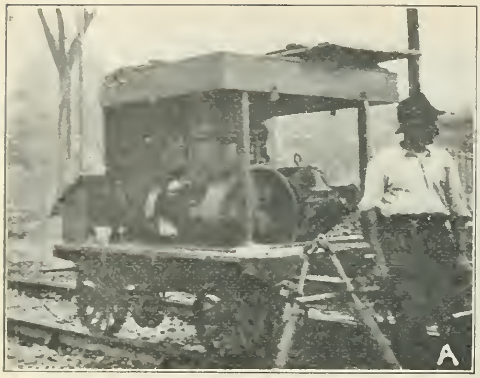


FIG. 3.

tamping machines. The Public Service Railway of New Jersey in extending its trackage in East Orange started tamping with two pneumatic tampers, Fig. 3, operated from a portable compressor. The average day's work of three men, two tampers and a shoveler, was sixty ties tamped on both sides for their whole length. Two-inch stone ballast was used and the track lifted 6 in. The foreman's comment to the writer was that ten men hand tamping might beat the two machines but six men could not keep up with them. To expedite still further the construction work an additional double unit of two pairs of tampers, operated from a similar compressor of large size, was placed in operation, Fig. 4.

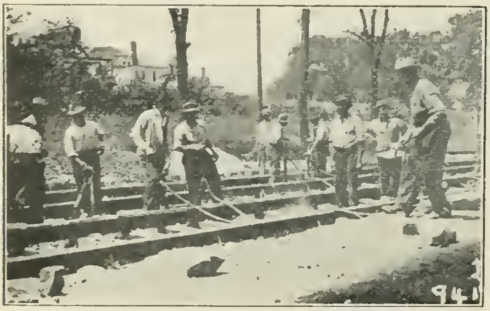


FIG. 4.

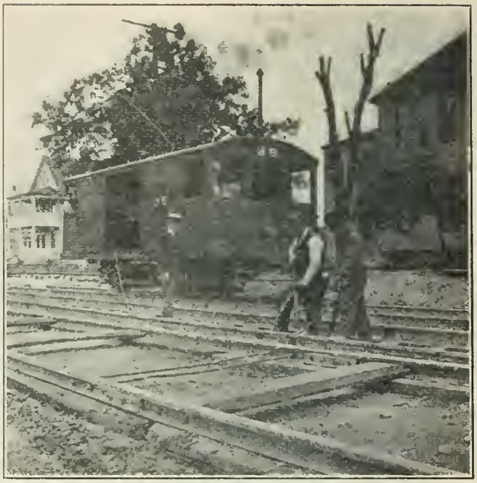


FIG. 5.

At Minneapolis the Twin City Rapid Transit Company prepares the roadbed for new track by grading with a steam shovel, dumping in stone ballast and rolling it smooth with a steam roller. A layer of gravel is then added, the ties and track are laid and sand gravel ballast dumped in for tamping. Observations show that on this work two men, Fig. 5, with pneumatic tampers do the work of eight men, Fig. 6, who formerly did tamping by hand. The average time required to tamp the full length of a tie on both sides is one and one-quarter minutes. When the operators noticed that their work was being timed they made a record of three-quarters of a minute. One of the most striking features of the work done here was a demonstration, Fig. 7, that a tamper could be operated by a one-armed man. The discovery was gratifying, not only to the individual but to the company on which he was dependent.

Thomas Crimmins & Sons, contractors for the laying and ballasting of the track on the

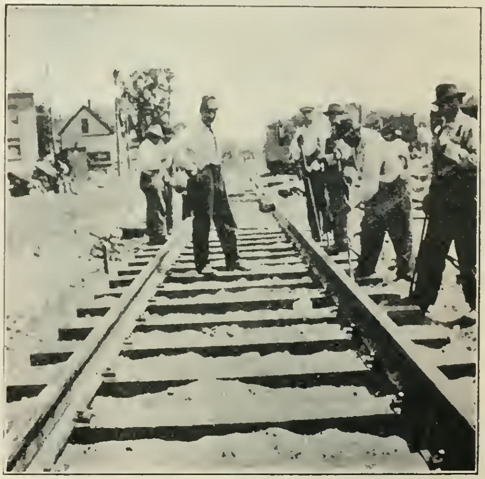


FIG. 6.

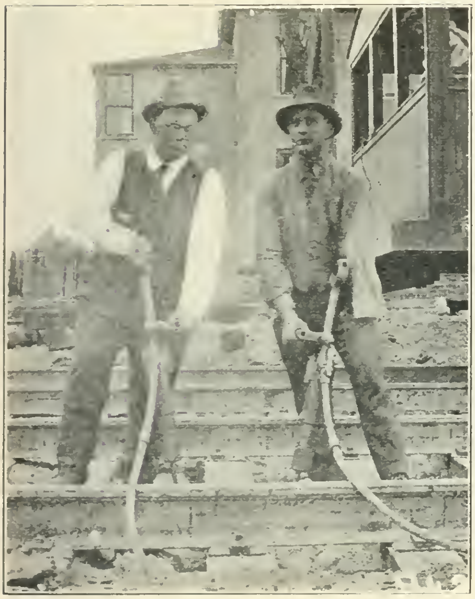


FIG. 7.

concrete viaduct of the rapid transit system extension in Queens Borough, New York City, used four pneumatic tampers, Fig. 8, operated from a gasoline driven compressor. The conditions here were rather unusual. The concrete structure had been filled between the sidewalls with 3-in. crushed stone, the depth varying from 5 to 10 ft. This was covered with a 3-in. layer of 2-in. stone, the track then laid and 2-in. stone ballast of an average depth of 12 in. dumped on for tamping. This construction necessitated very thorough work on the part of the tamping machines, to secure a permanently stable road-bed. An average of 550 ft. of track or about 367 ties per day were pneumatically tamped by a gang consisting of four men operating the tampers, two men shoveling ballast and four jacking up and aligning track.

On one of the lines of the Indianapolis Traction & Terminal Company, Indianapolis, Ind., the failure of continuous welded track due to excessive warping made relaying necessary. After employing six men shovel-tamping the dirt gravel ballast two pneumatic tampers were tried out and found to do more work than the hand labor, which they replaced. While the time record of their performance was variable due to the necessary delays in replacing the warped rails, their efficiency of operation was very satisfying to the company. For supplying compressed air to the tampers a standard straight line Ingersoll-Rogler compressor was mounted on a heavy construction wagon together with a short-belted electric motor and air receiver.

COMPARISON WITH HAND WORK

Investigation of results seems to justify the claims that machine tamped track is of greater stability and permanence than hand tamped track. The results obtained by the New York Central may be of interest as an indication of the quality of the work done by this type of machine. As a test 800 ft. of track was machine tamped and a similar length hand tamped. At the end of six months the comparative stability was measured with the following results:

	Hand	Machine
Greatest Settlement...	0.116 ft.	0.063 ft.
Least Settlement......	0.018	0.004
Average Settlement...	0.067	0.033

This experiment was conducted on track over the Hackensack Meadows, New Jersey, where the foundation was soft, and for that reason not the ideal place for the purpose. The comparative results observed have been unofficially verified in electric railway work but exact figures have not been compiled.

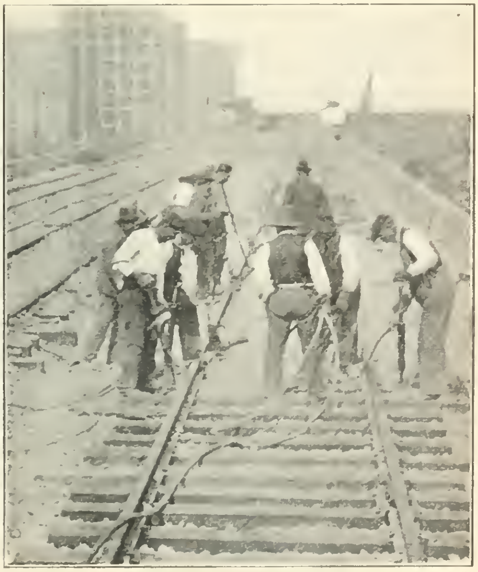


FIG. 8.

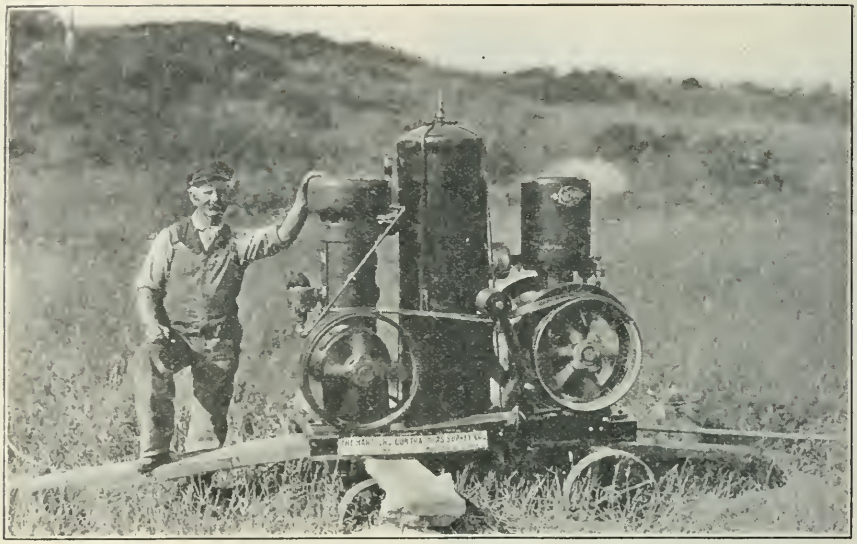


FIG. 1.

CONTRACTORS' PORTABLE AIR COMPRESSORS

The interesting half-tones here presented show examples of a new line of portable, self-contained air compressing outfits as engaged in actual work. These compressors are put out by the Hartford Contractors' Supply Company and are built of various capacities and with gasoline, electric or steam drive as may be required. The type shown in our present illustrations is known as the Hartford OH. Compressor.

It comprises a Novo 6 h.p. gasoline engine, self-contained and frost proof, and an Ingersoll- Rand, Type XII compressor, 4½ by 5 in., belt driven, with a floating idler pulley to maintain the proper working tension. The capacity of the compressor is 23 cu. ft. of free air per min. which is sufficient for drills of the hammer type which are now almost

FIG. 2.

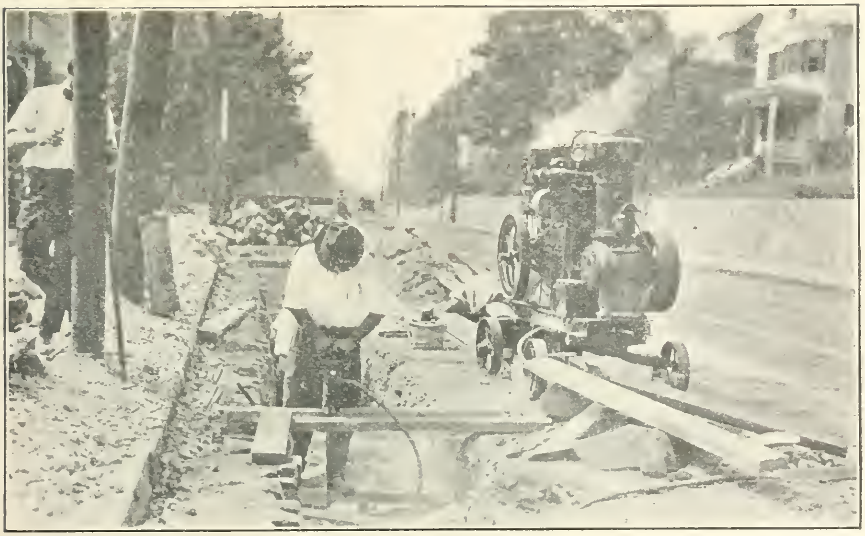


FIG. 3.

exclusively used by contractors. The cooling system employed on both compressor and engine is a self-contained reservoir, no tanks; the compressor has automatic unloader, relief valve and pressure gage and is also automatically lubricated. The air receiver is of ample capacity, 5 ft. by 16 in. and is provided with all connections and appurtenances. The truck, of heavy channel iron, is mounted on "Electric" wheels, and a swinging handle provides for drawing about by hand. If the compressor is to be handled over rough roads it can be furnished with heavier mounting and pole or shafts for horses.

The compressor shown running in Fig. 1 is in the service of the Guilford-Cluster Water Company, Connecticut. The drill, Fig. 2, 250 ft. from the machine, is putting down 5 ft. holes in hard rock at the rate of 1 ft. in 8 min.

A similar compressor seen in Fig. 3 is work-

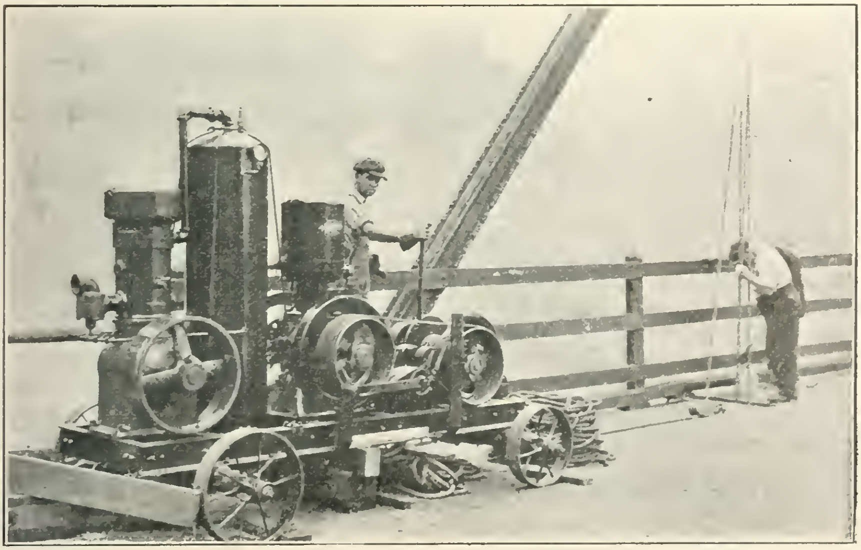


FIG. 4.

ing at Melrose, Mass., for the Fred T. Ley Company, Springfield, Mass., drilling flint rock preparatory to laying conduits. The builders state that the performance of this plant was so satisfactory that a duplicate order was immediately placed for shipment to Salem, Mass., to drill holes of special size, 3 ft. deep and bottoming at 2 in. diameter.

Fig. 4 shows a special adaptation of the OH. Compressor designed and built for the Connecticut State Highway Department. As here shown it is being used in the reconstruction of a 150 ft. steel bridge at Sandy Hook, Conn. The combination is ideal for the variety of operations in such an undertaking. It does all the hoisting called for, drives the rotating drills for steel, riveting hammer, holder on, calking, etc., and is of course always ready for rock drill work. The machine stands and works anywhere without blocking. It should be noted that the boom seen in the half-tone is not a part of the machine. The rope runs out horizontally from the hoisting drum to snatch-block secured to the deck.

THE TUNNELLING HEROES OF THE WAR

The following is extracted from an article by a mining engineer who is on the job.

The first companies organized for tunnelling work were enrolled from miners who were at the outset enlisted as ordinary soldiers, and were already trained men in France. Later on special companies were organized in England, and enlisted from the different mining districts in the British Isles. These men were sent out with very little military training, but they were experts at their own speciality, namely, mining. Their officers are, as a rule, mining engineers, who have knocked about all over the world. These were men who, in peace time, were making anything from £500 to £3,000 a year, but who threw up their jobs and came back to England at their country's call, enlisting, very often as privates, so as to get some knowledge of military work, and then when the call came for tunnelling officers they applied for and got their commissions in these specially organized companies. There are also a number of officers, younger men, who have just passed through the different schools of mines, and obtained commissions in these companies, and it is no uncommon thing to see a man of between 40 and 50, grey and tanned by many a hard year's work in the tropics, laboring as a second lieutenant under a youngster of 22 years of age, but it is all taken in good part as it is just one way of doing their bit, hard, at times, no doubt, but all have to swallow many old prejudices now-a-days.

The tunnellers are Royal Engineers, and wear that motto "Ubique" (for the general good), but perhaps a better motto for them would be "Guard the Infantry," for in trench warfare that is their all-important duty. If the enemy explodes a big mine near our front line, the first question asked the officer-in-charge at the time by his superior is: "Lost any infantry." and if any are lost careful enquiry is made as to how it happened no warning could be given. The second question will be: "Lost any of our own men," and if so a shrug of the shoulders follows, which means: "Well, its the fortune of war, we must expect to lose some men."

The work of the tunnelling companies is always interesting. They are continually at work, and the danger is ever present. The men are always, as it were, "up against it," and the essence and value of what they do lies in absolutely quiet working, so as to give the enemy as little indication of their whereabouts as possible, and also to preserve secrecy as to their work and methods.

In the trenches they work by the light of a candle "stripped to the buff," with the knowledge that at any moment the enemy, who, as a rule, can hear the picking going on, and is often only a few feet away from them, may fire a defensive mine and put them out for ever. Again, after an enemy's mine explosion, or even when one of their own mines has been exploded, the miner may drift through the strata, often several days after the explosion, and before he realizes that he is working in a deadly atmosphere in which he may be rendered unconscious, and unless very speedily rescued die of gas poisoning.

He may also sit silent and alone in a listening gallery with nerves trained up to concert pitch listening to catch every faint indication of the position of the enemy, and trying to piece together, from every slight noise, what "the man on the other side of the wall" is up to. A nerve-trying job this, in a long, dark gallery 4 ft. by 2 ft., without even a candle, but a tunneller must have no nerves.

Away out in front of our front line, right out in "No Man's Land," down under anything from 30 to 150 ft. from surface, sit or lie that line of silent sentries. Those silent guardians of our front line trenches are really and truly our first line of defence. Silent, but ever watchful, with ears trained by experience, and nerves hardened by years of work in the mining districts at home, these men do their invaluable work. Our Colonies have also organized and sent out to us tunnelling companies. There also work there strong, silent men, the men who made this defensive line, and who are now working to carry their galleries under the lines of the Huns themselves, for in offensive, as well as in defensive, work it is a case of "Guard the infantry."

If a bombing raid or an attack in force is made on any part of the enemy's line it is generally preceded by a series of mine explosions under their front line, for the successful working of which the mining company is responsible.

Ask the infantry if they "go over" after a series of mine explosions what do they find. They find demolished trenches, dead men, and demoralized men, instead of machine guns prepared to pour their deadly hail of bullets into unshaken men ready and waiting to decimate their ranks. So in the offensive, as well as in the defensive, the cry is "Guard the infantry."

Just one case, put as shortly and crudely as possible, but a true case. Four mines were to go under the enemy's lines on a certain date and at a certain time. Fairly stiff clay, but for the eight out of ten days they had to do it in, the men on each gallery did their 30 ft. a day in eight-hour shifts, galleries 4 ft. by 2 ft., not a stick of timber, not a sound, with feet cased in sandbags to prevent noise and preserve absolute silence. The sound of the tramping feet above them told them they were under the Hun lines. One gallery broke into a Hun gallery close to their lines, where they were working, but the hole was plugged up and a pipe put in. For two days our interpreters listened to the conversation of the enemy's miners while silently but quickly explosives were brought along the galleries. At length the men "tamped up" right alongside where the enemy was working, and still remained undiscovered. Wires were trained up the shafts, batteries tested, and everything went according to time to the very minute. The British public seldom stop to think, when they read that small and laconic notice in a paper: "We exploded a mine at ——, and occupied the crater," of the preceding work and anxiety entailed upon the officers and men "down under." The tuneller's reward is that the infantry, in common with the higher command, know what they owe to the tunnellers. I have seen a tunnelling officer come back after a "Push" of this sort dead-beat himself, wet, cold, and plastered with mud, with "My God! every one of these men of mine deserves the V.C., they've behaved splendidly.

WIND CAVE

Wind Cave in the Black Hills, National Park, South Dakota, on the Denver-Deadwood scenic highway and about twelve miles from Hot Springs, is claimed by enthusiasts to excel the Mammoth Cave of Kentucky in splendors and in extent. Half a dozen government surveys have been made in the park. These and various private exploring expeditions that have been organized have accounted for some 96 miles of the recesses of Wind Cave, but there are hundreds of passageways that have never been explored. No one knows to what depths they lead, or how far under the Black Hills they may take the explorer. The average visitor to Wind Cave, National Park, travels from six to ten miles underground and comes forth into the daylight realizing that he has seen but a small fraction of this great cavern.

Wind Cave takes its name from the strong current of air which almost constantly surges inward or outward at the entrance, this phenomenon having led to the discovery of the cave in 1881. There have been many speculations as to the cause of the air movements, but a very plausible explanation is easily suggested. The cave, as is evident, contains an immense volume of air which we may assume normally corresponds in pressure to the mean pressure of the atmosphere outside the cave. There is nothing within the cave to change the pressure of the air, while the pressure of the atmosphere outside is constantly changing, as indicated by the barometer. It would be quite natural to expect, therefore, that with a falling barometer there would be a rush of air out of the cave, while with a rising barometer the rush would be into the cave until, in either case, the pressures within and without the cave would be temporarily equalized.

PRINCIPLES OF REFRIGERATING SYSTEMS

BY M. A. SAHLER

When a substance passes from the liquid to the gaseous state, the change is always accompanied by the absorption of heat, which is commonly called the latent heat, *i. e.*, the hidden heat which cannot be measured with a thermometer. For instance, when water is heated under atmospheric pressure the temperature will rise until it reaches 212 degrees. Further heating of the water at 212 degrees will change it into steam at 212 degrees. The heat which is absorbed while the water is being changed from liquid to steam is the latent heat, or the heat of evaporation. This law, to the effect that a substance passing from liquid to gaseous form must absorb heat, is taken advantage of for producing refrigeration, by making use of volatile liquids which absorb and give up their latent heat quickly and freely.

REFRIGERATING AGENTS

The three agents most generally used for refrigerating purposes are anhydrous ammonia, carbon dioxide and sulphur dioxide. Three desirable features in a refrigerating agent are, low boiling point, so that it gives up its heat at low pressures, permitting the use of light machinery and making it less difficult to prevent leakage; and low specific volume, so that less cumbersome apparatus is required; also great latent heat, resulting in great refrigerating capacity.

Anhydrous ammonia is the most widely used. This has a boiling point of 28 degrees below zero, a latent heat of 573 B.t.u., and a specific volume of 4.4. The main disadvantage of ammonia is that it corrodes brass and copper, and consequently all piping and fittings must be made of iron and steel. Leakage of ammonia in large quantities is also dangerous to human life.

Carbon dioxide has a boiling point of 110 degrees below zero, a latent heat of 140 degrees and a specific volume of 1. The chief advantage of this is that it is non-inflammable, non-explosive, and not dangerous to human life unless present in very large quantities. The main disadvantag is the high pressure which is required to liquefy it, this running from 750 to 1,000 pounds. The carbon dioxide machine is suitable for small compact intallations, and because of this and its inoffensive odor, it is widely used on shipboard. It is also non-corrosive.

Sulphur dioxide, or sulphurous acid, has a boiling point of 14 degrees below zero, a latent heat of 162 degrees and a specific volume of 13. The main advantage is that it liquefies at very low pressures, but this advantage is offset by the fact of its high specific volume which requires large cumbersome machinery. Air leakage into such a system results in the formation of sulphuric acid which is extremely corrosive.

COMPRESSION SYSTEM

In the compression system the compressor takes the ammonia which has been evaporated in the expansion coils in the tank and forces this vapor under pressure into the condenser, and when it strikes the cool surfaces of the condenser, cooled by means of cold water circulating over the tubes of the condenser, the gas gives up the heat which it has absorbed in the expansion coils and is condensed into liquid form. The liquid ammonia thus produced then passes to a liquid receiver from which it is admitted as desired, through a throttle valve, into the expansion coils, where it again begins to evaporate and consequently absorbs heat, and gas is pumped out of the coils by the compressor, passes to the condenser, is condensed, and thus goes around the circuit indefinitely.

The compressor does not change the vapor into liquid, but merely reduces its volume and thus increases its temperature, *i. e.*, the latent heat which is taken up in the process of evaporation in the expansion coils is changed into sensible heat at the high pressure, and this sensible heat is then given up to the cooling water in the condenser. The degree to which the ammonia vapor is compressed depends on the temperature of the water used in the condenser.

Where all the ammonia is evaporated into gas in the expansion coils, and returns to the compressor, it is called the dry system. Where some of the ammonia after passing through the expansion coils is in liquid form, the liquid being caught in a trap or accumulator, and repassed through the coils, while the gas is separated from it and returned to the compressor, it is called the flooded system.

In the dry system the heat is transferred from the liquid outside the coils to the gas

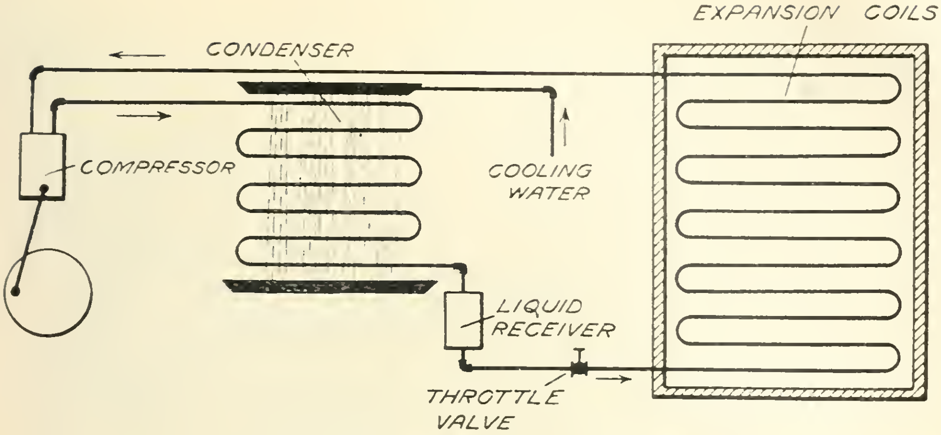


FIG. I. COURSE OF THE AMMONIA IN A COMPRESSION SYSTEM.

inside the coils, while in the flooded system the heat transmission is between liquid on both sides of the coils, and since the transmission of the heat from a liquid to a liquid is much more rapid than from a gas to a liquid more rapid refrigeration can be obtained with the flooded system, and for a given capacity less refigerating surface is required, or for a given refrigeration surface greater capacity is secured. The flooded system requires less evaporating surface than the dry system, but it requires a greater initial amount of ammonia, although a smaller compressor may be used.

ABSORPTION SYSTEM

The principle involved in the absorption system is the absorption and repulsion of ammonia gas by alternate cooling and heating, water being used as the absorbing medium. The refrigerating agent is aqua ammonia or ammonia water, a mixture of anhydrous ammonia and water in the proportions of about one and two, respectively. This ammonia water is placed in a generator, where it is heated by steam coils containing low pressure steam, usually the exhaust from the circulating pump, and due to this heat ammonia gas under

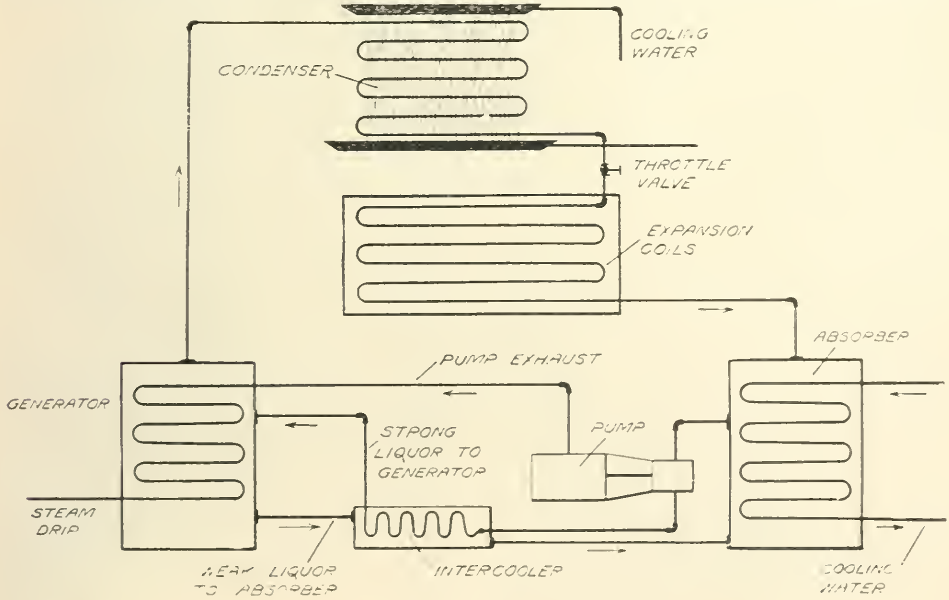


FIG. 2. DIAGRAM OF ABSORPTION SYSTEM.

pressure is liberated from the water and passes on to the condenser where it is cooled and liquefied.

The liquid ammonia then passes into the expansion coils, and the warm gas from these flows into an absorber, a tank containing the weak aqua ammonia, *i. e.*, that which has previously given up its gas in the generator. In the absorber are coils containing cold water, and the ammonia vapor coming from the expansion coils is absorbed by this weak aqua ammonia, and the heat given up by the gas in the absorption process is carried off in the cooling water. The strong liquor or strong aqua ammonia resulting from the absorption of the ammonia gas is pumped into the generator where it is again driven out of solution by the heating coils, and so around the cycle indefinitely.

The strong liquor going to the generator passes on one side of a set of coils, while the weak liquor from the generator to the absorber passes on the other side of the coils. Hence some of the heat in the weak liquor is given up to the cooler strong liquor going to the generator. This interchange of heat relieves the generator and absorber of just so much work, and increases the capacity and efficiency of the apparatus. These intercooling coils are called interchangers or intercoolers.

The main advantage of the absorption system is that the only power required is that necessary to circulate the liquor from the absorber to the generator, and this is usually done by a steam pump, the exhaust of which is utilized in the generator. However, a greater amount of cooling water is required, since cooling water is not only required for the condenser but in the absorber.

COMPRESSED AIR FOR PERPETUAL MOTION

We do not know why compressed air should not be as good as anything for the use of the perpetual inventor of perpetual motion. The following is from a local paper:

Mr. Charles H. Winne, of this city, has recently completed the invention of a device on which he has been at work for the past eleven years. This device consists of an air motor, which the inventor claims may be installed on manufacturing plants, vessels and railway cars, and claims that by its use power will cost nothing after the cost of installing the machine. In other words those who install machines after the pattern of his invention will not be called upon to meet monthly bills for electric current as most manufacturers and others who use electric power do to-day.

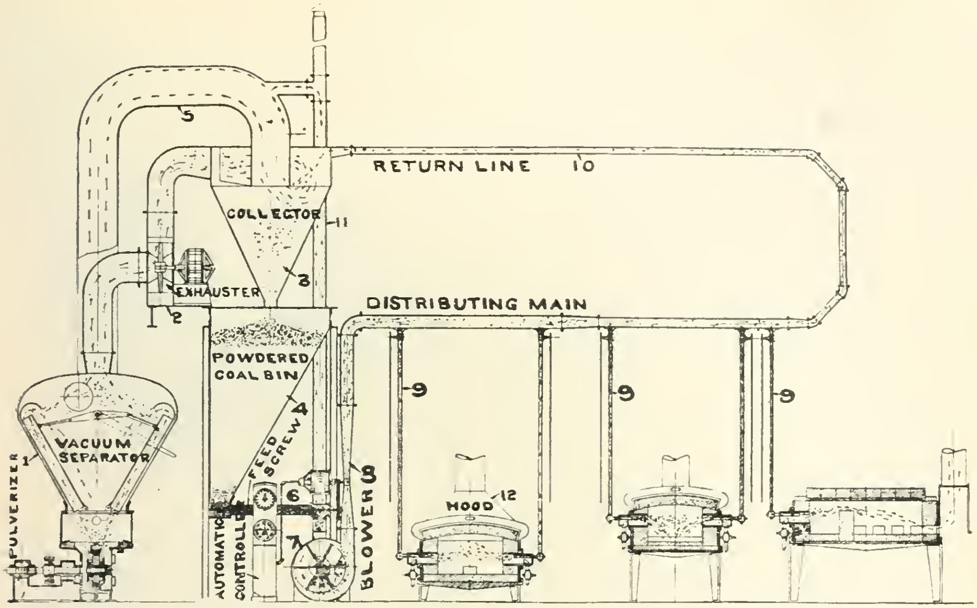
Through a well known Washington firm of patent attorneys, Mr. Winne has filed an application for a patent on his invention with the United States patent office, and is hoping for favorable action on it. The device consists, roughly speaking, of a large revolving wheel which will be kept in perpetual motion through air pressure, currents of air being led to the wheel through a series of conduits, so arranged that a strong draft or suction is possible at all times.

It must not be taken from the above description that the device is patterned after a common windmill, which requires that wind shall be blowing in order to maintain its operation. On the other hand the motor can be operated on days when not a breath of air is stirring just as well as on days when the wind is blowing a gale, though on the latter days the amount of current which the device will generate will be greater than when there is little or no air stirring.

The motor is so protected that no matter what the weather may be, no rain or moisture will enter the casing to impair the efficiency of the apparatus. It is the inventor's claim that the air currents will drive the wheel around at a speed sufficient to generate an even current of electricity, and he further states that practical tests to which he has subjected the device have proven to his satisfaction that it will do all that he claims for it.

NOVEL COAL DUST EXPLOSION

A steam plant had occasion to use as a poker a 10-foot rod made of heavy tubing, one end of which had been hammered together, the other end being open. The open end was always thrust back into the coal pile after using with the result that some finely powdered coal found its way inside. It was decided, however, to close the other end also. The next time the poker was used to any extent there was a terrific explosion that tore the poker apart and hurled the fireman against the boiler. It was thought that a quantity of the powdered coal remained in the tube.—*Electrical World.*



A PNEUMATIC SYSTEM FOR BURNING POWDERED COAL

The cut on this page shows diagrammatically the essential features of a pneumatic system especially adapted to the requirements of metal heating furnaces which has been developed by A. A. Holbeck of the Bonnot Company, Canton, Ohio. The installation of this system makes it possible to distribute the fuel to a number of widely separated furnaces, the coal pulverizing plant being necessarily located some distance from either.

Bituminous crushed, nut or slack coal is stored in a bin, preferably made of steel or concrete. The coal passes from the bin and an automatic feeder regulates the amount of coal fed to the pulverizer, shown at the extreme left. As the coal becomes pulverized it is thrown up into the vacuum separator 1 by the action of the pulverizer. This separator separates the fine particles of coal dust from the coarse, the finest being drawn into the exhauster 2, the coarse falling down into the pulverizer.

From the exhauster 2 the powdered coal is blown into the collector 3. The expansion of the air as it enters the collector permits the coal dust that is carried in suspension to fall to the bottom of the collector and into the coal storage tank 4. The air that enters the collector returns through pipe 5 to the pulverizer to be used over again.

The coal dust is taken from the storage tank 4 by the feed screw 6 and delivered into the suction side of high-pressure blower 7. It is then blown into the distributing main 8, and carried to the furnace through the distributing pipes 9.

The coal which is not used at the furnaces is returned through the return line 10 to the collector 3, where it is extracted from the air and falls into the coal storage tank 4 to be used over again.

The air after the coal is extracted is returned to the suction side of the blower through pipe 11. The products of combustion from the furnaces are collected by the hoods 12 placed in front of each furnace, and are disposed of either by means of an exhauster or a stack.

TO MAKE AIR TIGHT BRASS AND BRONZE CASTINGS

The following is from a paper before the American Institute of Metals, Cleveland. Sept., 1916, by S. D. Sleeth, superintendent of the foundries of the Westinghouse Air Brake Company, Wilmerding, Pa.

Density and strength are the two qualities necessary in a metal suitable for the retention of air or other gases under pressure, and while strength may be secured through proper design, density is a quality not so easy to obtain. Density of a brass or bronze casting is affected by a number of variables, among which are the design of the article to be cast, the design of the pattern with reference to its position in the flask, composition of the alloy, treatment of the metal in the furnaces and temperature of the metal when poured.

All cross-sections of the part should be of approximately equal thickness in order to prevent draws of heavy portions. If this is not possible, access to all large sections should be provided for the use of chills to prevent draws. If the cored cavities are large, the cores themselves will act as chills. Fillets should be as small as possible in order that excessive masses of metal shall not be concentrated at one point.

The use of chills is almost always necessary. Chills should be used on all enlarged sections in close proximity to smaller sections and connected thereto. If the sections are exceptionally large, sinking heads on top of the large sections should be used. The molds should be gated with a heavy upright pouring gate as near the pattern as possible. The gate leading from the pouring gate to the pattern should be made large at the pouring gate and then reduced sharply into the pattern. If it is left large where it joins the pattern, in all probability it will show a draw in the casting at the gate. As a rule, it is better to gate in a light part of the casting than in a heavy portion. If a sinking head is used, it should be placed on the heavy part.

The treatment of the metal in the furnaces is of vital importance. If proper allowance for oxidization on zinc, etc., is not made, the alloy required will not be produced. The metal must be taken from the furnace as soon as it reaches the proper heat, for if allowed to soak in the furnace, it will take up gases, and the castings made from it may be porous. In pouring certain packing ring mixtures, the Westinghouse Air Brake Co. considers the time so important that an alarm clock is used to insure the metal being poured at exactly the right moment.

The temperature at which the metal should be poured is also vitally important; no doubt many castings are lost due to carelessness in this matter. If poured too cold, it is almost impossible to obtain solid castings, especially at the gates. On the other hand, if poured too hot, castings may be porous throughout. Great care must be taken to see that no aluminum is used in the mixture, as a very small percentage of aluminum will cause the castings to leak. Antimony and iron will do the same, but not to so great an extent. Aluminum has a peculiar action on the metal. The castings will appear solid and will not show a draw, but when under pressure will leak all over.

The following compositions have been tried and found satisfactory for air containers:

Metals	No. 1 Alloy	No. 2 Alloy	No. 3 Alloy
Copper	72.50	82.00	83.00
Tin	1.75	7.50	11.50
Zinc	19.25	4.75	4.00
Lead	6.50	5.75	1.50
Total	100.00	100.00	100.00

No. 1 alloy is used for ordinary castings, such as cocks, pistons, bushings, etc. It is easily machined, but is not suitable for very high pressures. No. 2 and No. 3 alloys are suitable for high pressures and are harder to machine than No. 1.

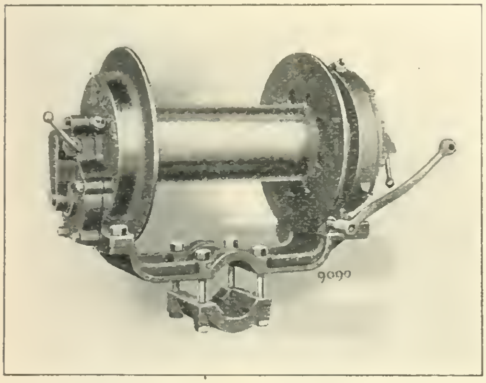
ROOSEVELT DRAINAGE TUNNEL RECORD

A remarkable record is being made in the driving of the Roosevelt drainage tunnel in the Cripple Creek mining district. The material is a hard volcanic breccia, with occasional dikes of basalt and phonolite, also very hard. The tunnel section is 9 ft. wide by 8ft. high in the clear, with a ditch or waterway at one side 4 ft. wide and 2 ft. deep.

The drills used are the Ingersoll-Leyner, Model 18, with 2¼ in. bits for starting. Two drills on a horizontal bar are worked in each shift. Usually it takes at least 30 holes to break a round. From 5 to 7 ft. only is broken per round. Little timbering is necessary, but water seems to come out of every fissure and crevice, the total flow at the portal now being 10,300 gal. per min. This makes it necessary for the men to wear heavy rubber boots and clothing. The rock is hauled from the face and hoisted out of the Elkton shaft.

The record for the 27 days worked in August, three shifts of eight men, was 437 feet. The best previous record was 400 ft. in January, 1909. The tunnel is four miles long now and it is intended to drive it 6,400 ft.

farther to the Golden Cycle shaft, although it is now rapidly draining the entire district. Charles F. Fuller is superintendent, and T. R. Countryman is chief engineer.



A NEW MODEL LITTLE TUGGER HOIST

For the use of those who prefer manila rope to wire rope for light hoisting and hauling, the Ingersoll-Rand Company has brought out a new model Little Tugger Hoist which is designated No. 11.

The square piston, reversible driving engine, automatic lubrication, enclosed gearing, drum release clutch and worm operated band brake are essentially the same as in the No. 1 model which has come into extensive use since its introduction a couple of years ago. The main differences are in the diameter and length of the drum, the width of the flanges and, necessarily, the main frame and over all dimensions.

The new No. 11 Little Tugger has a hoisting drum 7 inches in diameter by 17 inches long with 5 inch flanges. This accommodates 300 feet of ⅞ inch manila rope. The maximum capacity of this hoist is conservatively rated at 600 pounds. The weight of the hoist itself is 358 pounds. It is 21½ inches long, 31¼ inches wide and 23 inches high

Like the No. 1, the No. 11 Little Tugger is built for operation either by compressed air or steam. The standard clamp fits a 4½" diameter column or pipe, but by removing the clamp the hoist can be readily bolted directly to any convenient support, timber, flooring, etc.

Although designed primarily for underground work it is recommended by the manufacturer for all around hoisting, hauling and handling in mines, tunnels, quarries and industrial plants.

DIVING HELMETS ALWAYS AT HAND

At page 8117 of our September issue was shown a novel application of the now practically obsolete diving bell which may lead to its rehabilitation, at least for emergency use. The diving bell in this case may be any open ended vessel inverted and resting on the shoulders. Air is led to it by a hose from any source and entirely regardless of its pressure so that it is not less than the pressure of the water at the depth to which it may at any time be submerged. The arrangement is so obvious that it should have been used years ago, and it is not easy to believe that it was not.

The illustrations here reproduced from *Engineering News,* show two applications of this device which were employed in emergency under-water work by J. J. Griffin, Engineer-Superintendent of the New York Dock Co., foot of Montague St., Brooklyn, N. Y. Fig. 1 shows the first of these and explains the work on which it was employed.

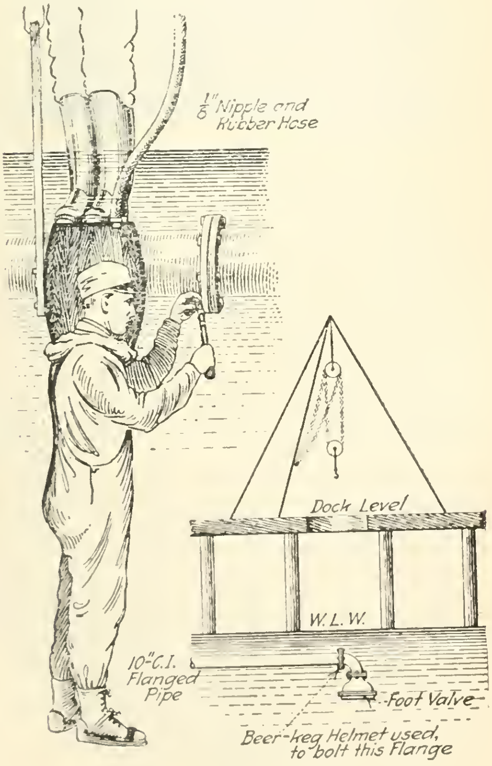

1/8" Nipple and Rubber Hose
Dock Level
W. L. W.
10" C.I. Flanged Pipe
Foot Valve
Beer-keg Helmet used, to bolt this Flange

FIG. 1.

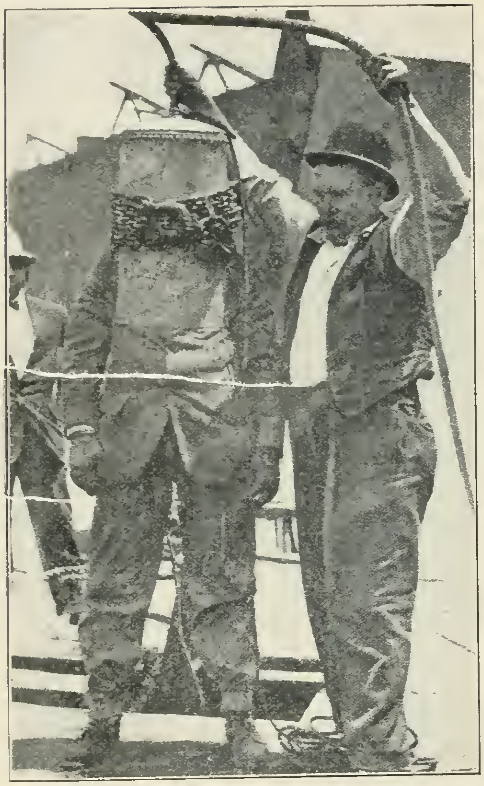


FIG. 2.

It was necessary under one of the wharves to connect up a 10-in. fire line—under water and in a limited time. It was impossible to do this from the wharf or from a boat, and a diving helmet was not available. A satisfactory helmet was obtained, however, by knocking one head from an empty beer keg. To steady the keg and overcome its buoyancy when submerged, a man stood on top, holding to a strip of wood that was nailed to the keg. With this extremely rough outfit it was possible for a man to stay down 1½ min., using only the air imprisoned in the keg. The pipe was bolted to the elbow successfully.

For later work on this same fire line a ⅜-in. brass nipple was fitted into the head of the keg, and to this was attached a rubber tube, through which air was forced by means of a common foot pump. With this arrangement—which was used only in shallow water—a man could stay down about 8 min.

Fig. 2 shows the next step in home-made diving helmets instituted by Mr. Grafflin. This arrangement is one end of an ordinary kitchen boiler notched to fit the shoulders and weighted with chain, as shown. With this rig and an ordinary duplex automobile pump it was possible to stay down 15 min. at a depth of 30 ft. The contrivance was used in the summer of 1914 to clear out in front of the intake to a 1,500-gal. per min. centrifugal fire pump located at the New York Dock Co.'s German-American stores.

In this outfit, as in the case of the keg, there was no window. This omission was not an item of importance, inasmuch as the sense of sight is of no service under the East River. Diving work there must ordinarily be done in the dark. As a general convenience, however, the boiler helmet was ultimately provided with a window, which was merely an oblong glass paperweight cemented to a hole cut in the front of the helmet. With the present rig (Fig. 3) and a regular deep-sea pump Mr. Grafflin has stayed down 1½ hr. This helmet was used in the summer of 1915 to excavate about 1½ yd. of silt and rock in 10 ft. of water, in a space not over 3x4 ft. in plan. The excavation was at the intake of the same centrifugal fire pump before mentioned and was to permit the installation of the screen in front of the intake (Fig. 4). Fig. 5 shows the screen in place and indicates the service it performs.

The rough helmet described has the advan-

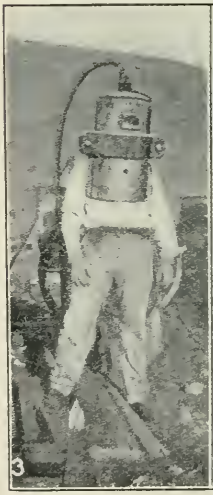


FIG. 3.

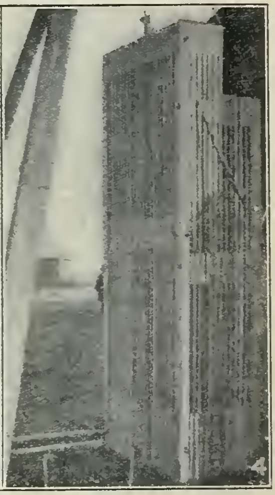


FIG. 4.

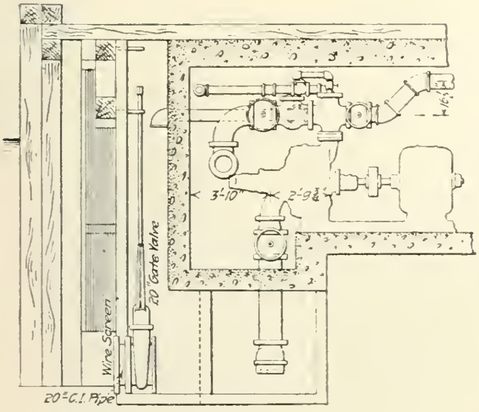


FIG. 5.

tage of occupying only about one-half the space of a regular helmet. The sandals were made by the company blacksmith from ¾x4-in. iron. They are provided with a ⅛x1½-in. strap across the toe and tied above the instep with sash cord.

AIR PRESSURE MINE SPRINKLING CAR

BY F. F. JORGENSEN

The ordinary type of sprinkling car used in mines is a wooden tank mounted on trucks, the tank having a large hole in one end at the bottom. Before filling the tank, a wooden plug is driven into this hole; and when the car reaches the piece of road to be sprinkled, the plug is removed. None of the dust except that between the rails is reached by the water, and that part is thoroughly soaked. This dust is usually not very harmful, for it is pretty well mixed with shale dust. The dangerous dust, of course, is on the ribs and timbers; and to reach this the sprinkler described in the following paragraphs was devised.

The device consists of a two-compartment steel tank mounted on trucks to run on track of any gage. The tank, as shown in the accompanying drawing, is equipped with two valves *H* and *G*, and two short lengths of hose, each having a quick-connection coupling numbered 1 and 2. The tank is also equipped with a valve *I* at the rear to which is attached the pipe connections 3. These connections are drilled in such a manner as to make a spray when water is forced through them.

Where the valves *H* and *I* are connected to the tank, a pipe connection on the inside runs close to the bottom of the tank. Two pressure gages *C* and *D* are connected to the tank, one in each compartment. The tank is also equipped with a pressure-reducing valve *E* and a check valve *F*, which are connected to the tank by means of pipe and pipe connections 4 and 5. These connections are located on opposite sides of the partition that divides the tank into the two air- and water-tight compartments *A* and *B*. Compartment *B* is equipped with a manhead to make it accessible for cleaning out and repair purposes.

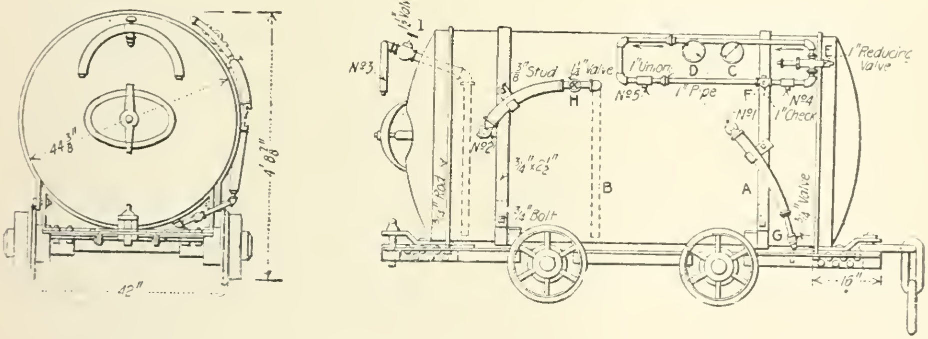


FIG. 1.

The operation of the sprinkling tank car is as follows: Hose 1 is connected to a compressed-air supply line, and the valve on the supply line and the valve *G* are opened, admitting compressed air into compartment *A*. When the pressure in compartment *A* rises above the limit set by the reducing valve *E*, compressed air begins to flow through pipe connection 4, reducing valve *E* and pipe connection 5 into compartment *B*. When the pressure in compartment *B* reaches the limit set by the pressure-reducing valve *E*, the valve

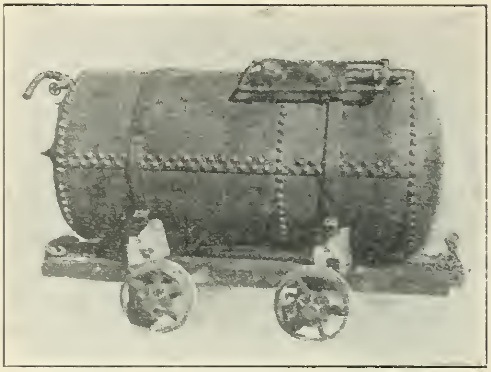


FIG. 2.

in the supply line and the valve *C* are closed, and the quick connection 1 is uncoupled. The limit set by the pressure-reducing valve may be anything desired, from zero up to the maximum pressure available in the supply line.

Connection is then made at 2 with the water-supply line. The valve in the water-supply line and the valve *H* are opened and water is admitted to compartment *B*. This water must be under great enough pressure to flow against the pressure in the tank. As the water flows into compartment *B* the air in this compartment is compressed and the pressure rises. When this pressure exceeds the pressure in compartment *A*, the air starts to flow from compartment *B* through connection 4, check valve *F* and pipe connection 5 into compartment *A*. When compartment *B* has filled with water, the valve in the supply line and valve *H* are closed, and connection 2 is uncoupled. The order of filling with air and water may be reversed; that is compartment *B* may be filled with water first and then compartment *A* filled with compressed air; but in this case the pressure of the compressed-air supply must be higher than in the first order of filling.

The tank is now ready to begin sprinkling. Both compartments *A* and *B* have the same pressure, but as soon as valve *I* is opened the pressure in compartment *B* drops to the pressure at which the pressure-reducing valve *E* is set. The air continues to pass from compartment *A* through the pressure-reducing valve *E* into compartment *B*, maintaining a constant pressure over the water in compartment *B* until the water in that compartment is forced out through sprinkler connection 3. The sprinkler 3 is so made and connected that the spray of water may be directed against the roof and sides of an entry, or in any other direction.

Any water getting over into the air compartment *A* when filling compartment *B* with water may be blown out through connection 1 by opening valve *G*.

The sprinkler may also be used for fire-fighting purposes, or any other purpose where water may be needed, by connecting the desired length of hose to connection 2 and opening the valve *H*. The accompanying photograph shows the tank, complete with all gages, valves and connections, mounted on a roller-bearing truck and ready for use. The car shown here has been in service for about nine months and has proved very satisfactory.

AIR PROPELLERS FOR BOATS

At first sight it might be considered that a propeller which revolves in the air can never be so efficient as one turning in the water where more resistance is offered, but there has during the past few years been a great advance in the design of aerial propellers, with the result that their efficiency is now fairly good, and may in certain cases exceed that of a submerged propeller. Their use as applied to motor-boats is still more or less in the experimental stage, and it is improbable that the best results have yet been attained; nevertheless, on comparative tests that have been carried out with the two types, it has sometimes been found that there is practically no difference in the speed of the boat whether a submerged or an aerial propeller be employed.

SPHERES OF APPLICATION

It may not at once be clear why there is any reason against the accepted means of propulsion, and in general it may be taken that the use of an aerial propeller is to be recommended only when there are special circumstances which render its employment specially desirable. Chief among its applications is perhaps in connection with shallow draught boats for service on rivers whose depth does not permit of the employment of craft with a greater draught than a few inches, or at the most a foot. There are many such waterways and rivers, and hitherto traders on them have been unable to reap the advantages of motor propulsion, especially as in most cases only a very low speed is required with a correspondingly large propeller, altogether out of proportion to the available draught of water. One of the special correspondents in Mesopotamia has given an account of a hospital ferry in use on the Tigris, which is fitted with an air propeller and a 50 horse-power semi-Diesel engine, and "makes more noise than a minor battle."

It might be thought that if submerged propellers are unsuitable for slow shallow draught vessels the aerial propeller would be equally inefficient, since it is apparently adapted for propulsion at high speed, and not at such speeds as those required for the vessels referred to, which may be no greater than three or four miles an hour. But from results attained by aerial-propelled tugs and barges it has been proved that this is not the case, and that aerial propellers can be designed efficiently both for relatively heavy low-speed craft and for light high-speed vessels of the skimmer or hydroplane type. In fact, it seems that these two classes of boats are the most suitable for aerial propulsion, and certainly by far the greatest number of examples at present in service are comprised in these categories.

As an instance of the success of aerial propulsion, a 30-foot boat, drawing only 9 inches, in which a 15 horse-power engine is installed driving an aerial propeller of about 8 feet diameter, has been in service for some time, towing some 15 or 20 shallow-draught punts, each loaded with about 2 tons. At the other extreme, there is the type of boat represented by an 18-foot skimmer, which attains a speed of 30 miles an hour, the machinery installation consisting of a 50 horse-power motor driving a two-bladed aerial propeller. These results, which may be taken as typical, appear to be equal to anything that could be attained by the employment of the same power driving a submerged propeller.

ENGINES AND PROPELLERS

All the leading types of motor have been employed for aerial propulsion, including the semi-Diesel, paraffin, and gasoline motors, the last only for high-speed boats As, in any case, there has to be a chain drive to the propeller, its speed of revolution can be varied within wide limits for maximum efficiency, to suit the craft which has to be propelled. This is a particularly advantageous feature, owing to the diversity of the boats on which aerial propulsion is used, and the speed of rotation of the engine does not have to be seriously taken into account when designing the installation.

It is an almost invariable rule to adopt two-bladed propellers, although there does not seem any reason why three or even four-bladed propellers should not be employed in certain cases, especially where a large blade area is desirable. In one or two instances tractors have been utilized, but this arrangement does not seem to give the best results, besides possessing the disadvantage of inconveniencing those who are on board, owing to the draught of air that is created. The question of danger with a rapidly-revolving propeller also has to be considered; this is minimized, if not entirely avoided, by properly protecting the propeller with an open wire netting.

There is little likelihood that the aerial propeller will ever in any sense replace the submerged type, since in the larger number of cases of the application of the marine motor to the propulsion of boats it does not offer any particular advantages, and indeed possesses some disadvantages. But there are many instances in which the submerged propeller is unsuitable or even impossible, such as in the extremely shallow-draught craft mentioned above, and it is here that a wide field of application for the aerial propeller is opened out.—*Engineering Supplement of the London Times.*

COMPRESSED AIR AT INSPIRATION MINE

The following is from a comprehensive paper describing the entire plant of the Inspiration Consolidated Copper Company, Miami, Arizona, by H. Kenyon Birch, chief engineer of the company, presented at the Arizona meeting of the A. I. M. E., September, 1916.

THE COMPRESSORS

Compressed air is used for two distinct purposes—for underground haulage and for mine drills. For the first 1,000-lb. air is used and 100-lb. for the second. The haulage system is served by two compressors, each having a capacity of 1,125 cu. ft. of free air per min. at 107 r.p.m. These are of the duplex four-stage motor-driven type, the cylinders being cross-compounded, water-jacketed and having intercoolers between the stages. These compressors have an automatic regulating scheme whereby, when a predetermined high-pressure point has been reached, the 1,000-lb. discharge line is cut out and the four cylinders are converted into a double-compound compressor discharging directly into the 100-lb. main. Each compressor is driven by a 430-h.p. self-starting synchronous motor.

The low-pressure equipment consists of two 100-lb. compressors having capacities of 3,000 and 7,270 cu. ft. of free air per min. Both compressors are of the parallel two-stage type, all cylinders being water-jacketed with intercoolers between the two stages. The 7,270-ft. machine is equipped throughout with Hoerbiger-Roegler plate valves, which, on account of the very short movement and exceedingly light construction, permit of a very high compression efficiency. The cylinders of this machine are 46 in. and 28-in. by 36-in. stroke. It is driven by a self-starting synchronous motor of 1,150 h.p. The 3,000-ft. machine is driven by a 500-h.p. self-starting synchronous motor at 107 r.p.m.

Two 100-kw. 125-volt motor-generator exciter sets arranged to operate in parallel serve as exciters to the compressor motors. Cooling water for the jackets and intercoolers is obtained from a circulating system consisting of a duplicate installation of 750-gal. triplex pumps and a spray cooling pond.

The compressors and hoisting equipment are housed in a spacious and well-lighted building which has a 25-ton electric crane running its entire length and connecting at one end with a well into which railroad cars can be run and unloaded. A 22-panel remote-control switchboard, together with the low-tension (2,200-volt) bus equipment, occupies a room along one side of the building, the high-tension transformer station being outside near one end of the building. Only two attendants per shift are required, one being an oiler. Without the automatic features for hoisting ore and the elevator for handling men, at least four would be required.

COMPRESSED AIR LOCOMOTIVES

Two types of motive power for underground haulage were considered—electric and compressed air. On account of less danger to life due to the elimination of bare conductors, the compressed-air locomotives was chosen rather than the electric. The difference in the efficiency of the two systems is probably a very small percentage of the total cost.

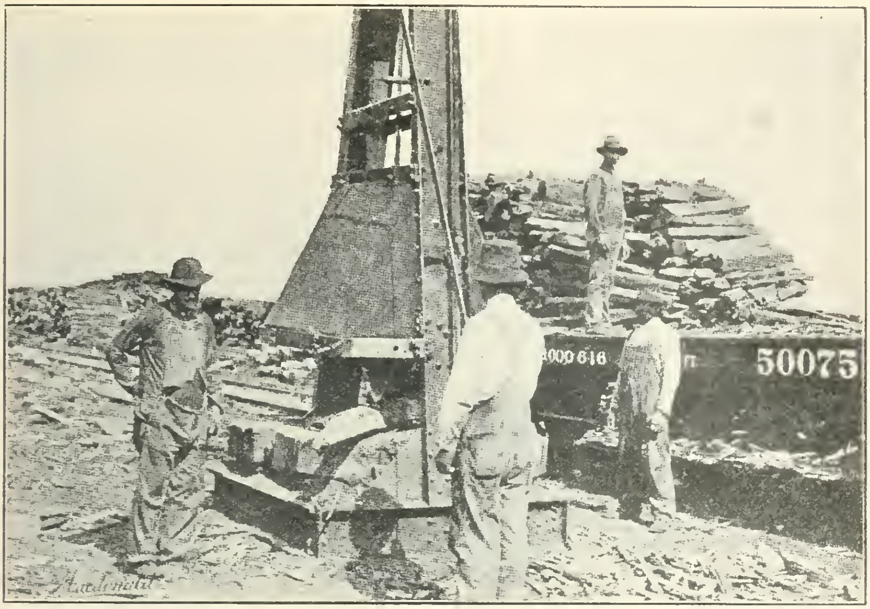
The locomotives are of the two-stage, four-wheeled type and have a weight on the drivers of 10 tons. The initial cylinder air-pressure is 250 lb. and the charging pressure 800 lb. per sq. in. The haulage capacity per charge was estimated at 500 ton-miles. The locomotives haul 25 cars, each of five tons capacity on a 30-in. gage track over a 0.4% grade in favor of the load, and will negotiate a curve of 38-ft. radius.

STEAM FOR MELTING SOFT METAL

In its manufacturing processes the Amalgamated Machinery Corporation of Chicago uses large quantities of type metal, an alloy of lead and antimony, for setting bearings and the like in cored castings. The alloy has a melting-point of 475° F., and it is essential that it be poured at a temperature not exceeding 550° F. Ordinary gas-heating melting furnaces such as are in common use for this kind of work necessitate the constant vigilance of an attendant using a thermometer in order to prevent overheating of the metal bath. It was thought that by means of a coil containing steam at sufficiently high pressure, the latter being kept constant automatically, the metal bath could be kept in proper condition, ready to be drawn from without an attendant. The pressure at which saturated steam has a temperature of 550° F., is 1050 pounds per square inch. It was found, however, that to insure transfer of heat, desirable to employ a temperature of 600° F., corresponding to a pressure of 1575 pounds per square inch. An apparatus designed by Winslow Brothers, of Chicago, consisting of a receptacle carrying a steam coil for heating a cast-iron crucible connected to a high-pressure boiler of special design, heated by gas, fulfilled the requirements. The details of the apparatus have worked reliably in practical operation, and it is possible to keep the metal in a melted condition at the desired temperature, ready for instant use, without more attention than a casual glance at the pressure gauge.—*American Machinist.*

OLD RAILROAD TIES FOR KINDLING WOOD

It has long been a question, without satisfactory solution, what to do with old railroad ties as they are successively replaced by new ones. A quite common practice has been to assemble them in piles alongside the track and set fire to them, but the wastefulness of the



BREAKING UP RAILROAD TIES.

practice has been a standing reproach. The wood is thoroughly seasoned and makes excellent kindling wood, so that it did not look well for a railroad to be buying kindling wood for its locomotives with this available supply costing money for its destruction. It is estimated that on the Burlington lines west of the Missouri above a million and a quarter of ties are thrown out every year.

The half tone here reproduced from the *Scientific American* shows a pneumatic tie splitting machine busily employed on the above lines. The device works on the principle of a steam hammer but uses compressed air for motive power, breaking up each tie into four pieces. A heavy weight to which is attached a knife resembling a huge spike is raised by compressed air to a height of 6 or 8 feet and allowed to drop, at one blow splitting the tie into two pieces lengthwise. These are then turned crosswise and another drop breaks or cuts them in two. The ties, having been thus cut into quarters, are loaded into cars for shipment to different points on the division as the wood is called for.

The tie splitting camps are isolated from the main railroad shops for fire protection. Piles of ties waiting to be cut up are several blocks long. The ties are transported to the tie splitter over a little stub line of railroad a couple of blocks long. Cars are placed on another track by the side of the tie splitting machine and the wood is loaded directly onto them as the ties are cut up. Old box cars that formerly were burned to get at the metal also find their way to the wood yard and are cut up for kindling wood.

WHERE WAGES HAVEN'T GONE UP

Surprise might be expressed that miners' wages in California to-day are nearly the same as in 1869. We are accustomed to think that the wages of all workmen in the United States have risen steadily since a generation ago, partly on account of the increased cost of living. This is exactly the reason why wages on the Mother Lode have not increased, because the cost of living there is lower than in 1869. In those early days the high freight-rates and the lack of agriculture in California made for high prices in most of the necessities of life. To-day a miner in California can, and does, support a family in comparative plenty on the wages that in 1869 only sufficed to keep a single man in good health and spirits according to the generous standards of those bluff times. The cost of living in California has increased recently by reason of the widening demand for luxuries, but a miner on the Mother Lode lives most comfortably in the snug mining towns, reinforcing his wage by the produce from his garden and by the modern facilities for economizing in the home.—P. B. McDonald.

THE ENGINEER

BY DR. FRANK CRANE

The man of the future will be the engineer.

He is the man who can Do things; and is better than the man who Owns things.

The Millionaire is a temporary, passing, makeshift product of civilization. He is merely holding things together until the people get sense enough to do their own owning.

Some day little boys will read that the world once had millionaires and huge private wealth units, just as they will one day read and wonder that men once had kings.

But the official who will forever be indispensable is the engineer.

The time will come when the President of the United States will be chosen as the man who has the greatest talent and skill in organizing public works. There will be no more politics in his selection than there is now in choosing the master mechanic of a railway or factory.

When a nation goes to war nowadays, that is, when it becomes necessary to exert its supreme collective strength, nobody dreams of electing the most popular politician or the cleverest speechmaker to lead the armies. It is the man who can get the last ounce of efficiency out of men and metal that is wanted.

Some day the nation will realize that it is continually in a crisis, and that in peace as in war we need the highest order of efficiency and organization.

We need the Engineer to arrange the transportation of people and goods from place to place, without waste, without competition, without graft, looking only to the public good.

We need the Engineer to get meat, bread, and milk from farm to citizen, without the present inefficient tangle of trusts and middlemen working at cross purposes.

We need the Engineer to turn the profit of public enterprise toward building good roads and bridges, instead of enriching a few shrewd manipulators.

We need the Engineer to manage a city as economically and smoothly as if it were a manufacturing plant.

We need the Engineer to organize the farmers so that all can work together for each and their products be marketed without being preyed upon at every step of the way from farm to household.

Wealth can be taken away from us. But the power to Do things cannot be taken away.

The Millionaires could go and not be missed. The Engineers we cannot spare.

"What availeth all thy wealth" said the ancient philosopher. "He that hath better iron than thee will come and take away all thy gold."—*Globe*, N. Y.

THE SAPPERS AND MINERS

BY BERTON BRALEY

When you read of a trench of soldiers
That's blown in the air a mile,
While the guns that flashed are broke and smashed
And the earth torn up in style,
You can write it down in your notebook
As soon as the dust cloud clears
That the canny chaps who ran the saps
Were the Army Engineers;
The human moles who live in holes
Where nary sun appears,
The grimy, gritty, far-from-pretty
Army Engineers.

They are miners who come from coal mines
To mine in the earth—for Men!
They are trolls and gnomes who make their homes
In a subterranean den.
So they tunnel beneath the foeman
Till they've got the business right
Then they spread the foe for a mile or so
With charges of alamite.
They do their work in muck and murk
With neither shots nor cheers,
These sturdy, plucky, mired and mucky
Army Engineers!

They must dig their drifts in silence
And chop their way by hand,
And the dirt they pack on each sapper's back
And scatter it on the land;
For they mustn't leave any traces
Which the enemy sees or hears,
Or they'll get a lift from a counter-drift,
That's bad for the Engineers!
Yes, now and then they lose their men
Amid war's hopes and fears,
They know the hell of war full well
The Army Engineers,
The muddy, bloody, sweaty, loyal
Army Engineers. —*Coal Age.*

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. NOVEMBER, 1916. No. 11

CONTENTS

Mining Thin Coal Beds 8163
Don't Use Compressed Air 8164
Pneumatic Tamping Reduces Track Gangs 8165
Contractors Portable Air Compressors... 8168
Tunneling Heroes of the War........... 8170
Wind Cave 8171
Principles of Refrigerating Systems.... 8172
Compressed Air for Perpetual Motion.. 8174
Pneumatic System for Burning Powdered Coal 8175
To Make Air Tight Brass Castings..... 8175
Roosevelt Drainage Tunnel Record...... 8176
New Model Little Tugger Hoist........ 8177
Diving Helmet Always at Hand......... 8177
Air Pressure Mine Sprinkling Car...... 8179
Air Propellers for Boats 8180
Compressed Air at Inspiration Mine..... 8181
Steam for Melting Soft Metal.......... 8182
Old Railroad Ties for Kindling Wood... 8182
Where Wages Haven't Gone Up... 8183
The Engineer 8184
The Sappers and Miners................ 8184
Cooling-Water for Air Compressors.... 8185
Drying Air for Sand Blast.............. 8186
Handbook of Casinghead Gas 8187
Fire Fighting in Metal Mines 8187
Signals for Field Engineers............. 8189
Notes 8190
Patents 8191

COOLING-WATER FOR WATER JACKETS AND INTERCOOLERS

The following article, which we reprint from a recent issue of *Factory*, requires some explanation before it can be read understandingly. Water for cooling purposes is used for two different services in connection with two-stage air compressors, the one being for the water jackets of the air cylinders and the other for the intercoolers, only the former of these being mentioned in the article. While the water jackets are very necessary for all continuously running compressors, they really do very little cooling of the air during compression their principal use being for the purpose of keeping the body of the cylinder as cool as possible in favor of proper lubrication, etc. As a consequence a small quantity of water circulating through the water jackets is generally sufficient and the average flow or discharge from the water jackets will generally be found to be only slightly warmed.

The function of the aftercooler, however, is very different. This is expected to cool the entire body of air passing through the compressor, taking it in at the high temperature resulting from the first stage of the compression and cooling it to a temperature as near as possible to normal before it passes into the high pressure cylinder for the final compression. In the intercooler, therefore, the temperature of the cooling water rises rapidly and an active circulation of the water must be maintained, and if the same water is to be used over and over the problem of cooling it is an important one. It is the cooling water required for the intercoolers rather than for the water jackets which is principally dealt with in the article which follows:

During a recent campaign for reduced water consumption in a large foundry, two high-pressure air compressors invited particular attention. These machines were of the two-stage, two-cylinder type, and the intake pipe of the water jacket on each cylinder was connected directly to the city water main, while the discharge pipe emptied into the sewer. In other words, water for cooling the cylinder was used but once for this purpose. The daily water consumption of these machines was about six hundred cubic feet.

It was proposed to install a thermosyphon cooling system, so that the same water might be used repeatedly without waste. For this purpose a discarded steam boiler of seventeen hundred gallons' capacity was utilized. The intake pipe of the water jacket was connected to the bottom blow-off of the boiler and the water jacket discharge pipe into the top of the boiler. The boiler dampers were opened wide to facilitate complete circulation of air through the flues.

When this home-made cooling system was put into use the temperature of the water before starting the compressor was sixty degrees Fahrenheit, and at the end of the day a temperature reading showed one hundred and fifty degrees Fahrenheit.

In operating a compressor of this type, the low pressure cylinder receives its air from the atmosphere, compresses it to a pressure of forty-five pounds per square inch, and then delivers it to the high-pressure cylinder, where the pressure is raised to about ninety pounds per square inch.

It is desirable that the temperature of air taken into the high pressure cylinder be as near the temperature of the atmospheric air as possible, in order that maximum efficiency in power consumption may be obtained. It is estimated that each rise of eleven degrees Fahrenheit in temperature of air delivered to the high-pressure cylinder means an increase of one per cent. in the power required to compress a given quantity of air.

Under the previous plan with the Cooling water running direct to the sewer, it was possible to deliver air to the high-pressure cylinder at a temperature twenty degrees Fahrenheit higher than that of the atmosphere, while with the newly installed thermo-syphon system the temperature was at least seventy degrees Fahrenheit higher.

This indicated that the saving in water consumption was being effected at an expense of six to ten per cent. increase in power consumption, which was decidedly disadvantageous.

Water supplied to the barrels in the foundry was, at that time, obtained from a gravity water tank, which, in turn, was connected to city water main by means of a float valve. This arrangement of piping was changed so that the city water main was connected direct to the intake pipe of the air compressor water jacket, while the gravity water tank for supplying the water barrels received its supply from an outlet pipe located sixteen inches below the top of the boiler used in the water-cooling system.

As a result of this change, the thermo-syphon was placed under the city water pressure, and as the warm water was drawn from the top of the boiler for foundry use, a fresh, cold supply was injected into the cooling system from the city main.

After these changes were made no more waste occurred in the use of water. At the same time the total rise in temperature of the cooling water after a day's operation was reduced to fifteen degrees Fahrenheit.

This simple arrangement made it possible to save six hundred cubic feet of water a day without materially increased power consumption at the air compressor.—B. J. S.

DRYING AIR FOR SAND BLAST

The following question and answer we reproduce from the page of an esteemed and generally reliable engineering journal. The instructions given can scarcely be regarded as satisfactory, and are hardly in accord with discussions of the same topic which have appeared in preceding issues of the same publication.

"Air used for etching electric light globes is delivered into a tank in the basement of the building at a pressure of from 20 to 25 lb. From this tank it is carried to a smaller tank on the fourth floor and thence through a 2-in. header feeding 4 1½-in. sand blast lines. It is of great importance that no moisture reach these machines and I wish, therefore, that you would kindly tell me how to dry this air.

P. McN.

"A. In small installations there is little that can be done economically to secure dry air at the nozzle other than by the installation of tanks, such as you have in your line. A precaution, however, is to be sure that the discharge outlet from these tanks is taken from the top so that none of the moisture which may collect near the bottom of the tank will be carried on to the air jet. These tanks act as separators and should be drained occasionally, as circumstances require. In some large installations it is customary to refrigerate the air before it enters the air compressor, thus reducing the amount of moisture to a minimum, so that after the air has expanded at the outlet nozzle no moisture will be present. Another provision which also tends to reduce moisture and at the same time increase the power available in compressed air, is that of installing re-heaters. These raise the temperature of the air just before it is used, so that, during expansion in the tool, the temperature does not reach much below that of the atmosphere and with the precaution mentioned above of taking the outlet pipes from the top of the storage tanks, this arrangement will, in most cases, insure dry air."

As to the general problem of getting dry compressed air, there are two or three things to be remembered which should render the solution comparatively simple. In the first place there is no such thing as dry air, and at the best we can only get the air comparatively dry, or dry enough to satisfy the requirements in specific cases. The capacity of air for carrying water in the invisible or strictly vaporous condition varies with both its pressure and its temperature, increase of pressure reducing the capacity while increase of temperature increases also this capacity very rapidly. In the act of compression, while the moisture capacity of the air is reduced by the increase of pressure that capacity is increased much more rapidly by the increase of temperature which results from the compressing so that the air as it leaves the compressor at its highest temperature is dry air, although the actual moisture in the air has not been changed in any way. If this hot air goes into a receiver or tank near the compressor and passes through it without being cooled the moisture will be still in the air and will be carried along with it, and of course it will make no difference whether the pipe leading out of the receiver is at the top or at the side. If the air is conveyed through a long pipe it will cool quite rapidly, or if it has not far to go it may be cooled by passing through an aftercooler. In either case when we have the air *at its highest pressure and its lowest temperature* the same air which before was dry will now be wet air, and much of the water, enough of the water to satisfy the purpose, may generally be drained out of it. If the air at high pressure and low temperature flows along horizontal pipes the water will accumulate in low places or pockets along the line, and must be drawn off, or if the air has only a short run it may, after leaving the aftercooler, be passed through a steam separator or similar device and the water be got rid of in that way. The cooling of the air while at full pressure is the most necessary condition for draining the air, but the mere cooling of the air, as spoken of above, before it enters the compressor of course does not take any water out of it. The water that is dropped by the cooled air as it flows along, as mentioned a few lines above must be drawn off or it will be mechanically blown along by the air and make more serious trouble than if it had not been separated at all.

NEW BOOK

Handbook of Casinghead Gas, by Henry P. Westcott, Metric Metal Works, Erie, Pa., 285 pages 7¾ by 5-in., 55 illustrations, 100 tables, price $2.00.

Casinghead gas had been the familiar accompaniment of the mineral oil industry from the beginning, but its importance and value were not at first recognized. It is estimated, however, that in 1915 thirty billion (30,000,000,000) cubic feet of casinghead gas was used in making gasoline by the compression process alone. This book gives in compact form the most important information upon the general topic and then the details of gas manipulation and utilization in most practical form. It treats of the testing of casinghead gas wells, analyzing apparatus for gasoline content, Orsot apparatus for determining oxygen in gas, the absorption process, construction of plant, pipe lines, carbon block from residue gas, etc., and then the formulas and tables for handy use by those in any way in touch with the industry.

DIFFICULTIES IN FIRE-FIGHTING WORK IN METAL MINES

In some respects fire-fighting and recovery work is much more difficult in metal mines than in level coal mines. Although fire damp or inflammable gas is frequently an additional menace in coal-mine fire recovery operations, this is often more than overbalanced in metal mines by the fact that operations may be carried on simultaneously on a number of different levels, some of the deep metal workings being nearly as far from the surface by a vertical or inclined measurement as some coal workings are by a horizontal measurement. So metal-mine rescue and recovery operations often necessitate continual descending or climbing on the part of the rescue crews. This is a serious and dangerous handicap, the effect of which should not be overlooked or underrated. The men generally feel more seriously the burden of the weight of the rescue apparatus and are hampered to greater extent by its limitations than they commonly are in coal-mining operations except in steep dipping coal beds.

The general mine temperature and humidity encountered are frequently much higher in metal mines, and the men are weakened by these conditions. Also there is nearly always the danger not encountered in most coal mines of some member of the rescue crew falling into an uncovered chute while working in the smoke. Ladderways are frequently constructed with openings just large enough to admit a man. Rescue crews with apparatus have difficulty in passing through these openings, and there is danger of damaging the apparatus in attempting to travel such ladderways; hence the need in metal mine operations of better planning, which will be best brought to attention by recovery drilling.

The above is a sample extract from a mine rescue handbook just issued by the Bureau of Mines. The full title is: "Rescue and Recovery Operations in Mines after Fires and Explosions." The authors are James W. Paul and H. M. Wolflin, the former dealing with coal mines and the latter with metal mines. There is less than 100 pages of actual text, but these are filled with practical information and suggestion. The size of the publication 4½ by 6-in., just one-half the usual size of the Bureau pamphlets, makes it handy for the pocket. It is distributed freely upon application at first, the later standard price being 10 cents for paper covers, and 25 cents in red buckram.

HOW ONE THING LEADS TO ANOTHER

That labor-saving machines economize work is unquestioned, but that a further advantage ensues from providing more work is not so well understood. Putting a mechanical drill-sharpener in a mine's blacksmith-shop immediately effects reduction in the cost of sharpening the drills. But, as pointed out by the *Compressed Air Magazine*, the consequent ease and quickness with which drills can be sharpened leads to more frequent sharpening of them; that is, when a bit becomes worn, the miner does not waste time trying to work with a dull tool, but changes to a sharp bit; he knows that dull bits can be sharpened easily and cheaply. This procedure is typical. The speeding of one link in a chain of connected operations is likely to spur others, and one improvement leads to another. The principle that the saving of work makes more work sounds paradoxical, but is quite as true as the axiom that "money makes money, and the money that money makes makes more money."
—P. B. McDonald in *Mining and Scientific Press.*

OZONE IN WAR SURGERY

Among the branches of surgery to which the exigencies of the European war have acted as a sharp stimulus may be mentioned the treatment of infected wounds. The proportion of patients who reach the military hospitals with their injuries thus aggravated is so large as to have given great importance to the subject of antiseptics, since obviously the perfect aseptic treatment which most cases can enjoy in ordinary hospitals in time of peace is out of the question for the majority of battle wounds.

Many antiseptics, unfortunately, though excellent germicides, are so toxic that there is danger of their harming the vitality of the tissues surrounding the wound. For this reason hydrogen peroxide is admirable, since it is germicidal without being in any way injurious to healthy cells. However, it is not adequate in those cases, so common in warfare, where there is a serious amount of suppuration. It is almost instantly decomposed, not only by pus, but by blood and most of the other liquids of the body tissues, so that the amount of mascent oxygen released is insufficient for the requirements of a serious wound.

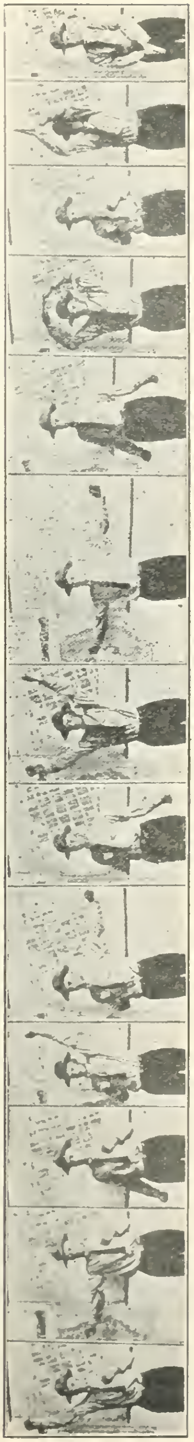
The search for an oxidizing agent not open to this objection led to the trial of ozone, either dissolved in water and used in copious irrigations, or in a gaseous state, mixed with ordinary diatomic oxygen. The latter style of treatment is especially advantageous in the case of wounds which are slow in forming a scab, since the most spacious bandages often have a tendency to rub off the fresh scab tissue. This difficulty is avoided in the process in question by surrounding the wound with a hermetically sealed shell, into which can be passed the gaseous current. This method possesses the extraordinary advantage of leaving the wound open to the beneficial action of the solar radiations as well. Then, too, the total exclusion of the ordinary air from the tissue under treatment makes impossible the formation of nitrogen compounds, which might prove decidedly irritant.

The other mode of application, through the use of ozonized water, has been found particularly satisfactory for large shattered wounds, where the tissues have been directly invaded by septic substances. The irrigation processes may be indefinitely prolonged without bad effect, thus making possible a methodical and efficacious cleansing of all infected tissues, whether they be deep or superficial. *Scientific American.*

SIGNAL CODE FOR FIELD ENGINEERS

The signal code embodied in the accompanying half tone, presented in a recent issue of *Western Engineering*, San Francisco, by Mr. W. R. Sherman, of Newman, California, may require some effort to memorize and some practice to use it without hesitation, but when once mastered it should be an acquisition of practical value.

In the starting position both hands rest on the breast, 11, and after each signal return to the same position. The different signals, corresponding to the illustrations, are 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0, and are self explanatory. For the alphabet the numbers corresponding to the alphabetic positions of the letters are given; that is A-1, T-20, Z-26, etc. The letters are separated by a dip and the words by a rise, both of which are shown. The dip and rise also indicate that letters, and not numbers are being given. The signals are shown in the accompanying illustration, commencing with 1 at the left, the positions for start, rise, and dip being on the right. Convenient practice may be had by two persons standing at opposite ends of a room and sending any copy, such as columns of figures, that may be at hand.



SIGNALS FOR FIELD ENGINEERS.

PNEUMATIC CONCRETE PRACTICE AT TWIN PEAKS TUNNEL

Twin Peaks Tunnel, a costly municipal improvement of San Francisco, forming a new highway on the line of Market Street, is to have a total length of nearly 12,000 ft. and about 8,000 ft. has been driven from the two portals. In the progress of the work various improvements have successively developed. In *Engineering News* we have a sketch of the operation of conveying and placing the concrete lining.

The concrete is conveyed and placed by the pneumatic process. Two plants have been installed, one near each portal. Specifications for concrete call for a consistency of 1 part cement to 2¼ of sand, with sufficient rock added so that the mortar fills the voids—approximately 5 parts. With every 100 lb. dry cement 8 lb. hydrated lime is mixed for waterproofing. From the mixers on the surface, charges are dropped through a measuring hopper into the air chamber, whence it is forced into the forms through a pipe with spiral projections to give the mixture a rotary motion. At the west end, concrete has been conveyed pneumatically 2,500 ft. up a 1.15% grade, and it is anticipated that a distance of 3,000 ft. will be served up the 3% grade from the east mixing plant. The sequence of the concrete operations follows: (1) 100 ft. of footing poured on each side; (2) second and third days following, footing forms stripped, tracks laid for form tower and steel forms set; (3) 40 ft. of side walls and ceiling slab started the third day after initial pour; (4) while section of walls and ceiling are being poured, the remaining wall and ceiling forms are set, excavation finished and next forms set.

A CONTINUOUS GAS LIGHTER

According to a report at the annual meeting of the Illuminating Society, the most striking innovation of the year has been the development of a gas glower for the ignition of gas lamps. This consists of a bundle, cylindrical in form, about one-quarter of an inch in diameter and of about the same length, made up of several thousand filaments made from rare earth material similar to that used in the incandescent mantles. Gas is delivered to the center of the mass and combustion takes place throughout but with greater intensity at the top. The device consumes approximately one twenty-fifth of a cu. ft. per hour or 350 cu. ft. per year, which is about one-half that consumed by the ordinary pilot flame of a residential burner.

FRESH AIR FOR SUBMARINES

A new process for supplying pure air to submarines has been discovered. The inventor, William G. Bond, of Wilmington, Del., recently demonstrated the use of his apparatus by remaining in a test chamber three feet by four feet by six feet for seven hours with only the air furnished by his device. The air is purified by a chemical reaction between carbon dioxide and certain solutions exposed to the atmosphere of the chamber. The carbon is absorbed and the oxygen liberated.

The test room used was entirely surrounded by water. Mr. Bond entered the tank, clad in a bathing suit and supplied with reading matter, food, air-testing apparatus and the chemicals. He kept in communication with the observers on the outside by means of a telephone. At a stated time, the supply of oxygen furnished by the apparatus was cut off and he remained for three-quarters of an hour longer. Though the air had been perfectly wholesome for seven hours, at the end of the forty-five minutes the inventor emerged breathing very heavily.

The value of this discovery to the submarine is yet undetermined. Its advantages are the simplicity of operation and the low cost of installation and maintenance. Let it be said, however, that any practicable method for ventilation of the submarine will be welcomed.—*Popular Science Monthly*.

NOTES

Tin now ranks first among Bolivia's mineral exports, having displaced silver in 1915. The exports of tin last year were 36,492 tons, valued at $16,300,000, copper exports ranking second at 23,812 tons, valued at $5,200,000.

In its ability to produce war orders completely within its own plant, the Nova Scotia Steel & Coal Company occupies a unique position. Out of the many thousands of cars built in America, in the past year for the Russian Government, that company, with its order for 2,000 cars, is probably the only builder which mined the ore, fabricated the material and delivered the cars in Asiatic Russia without calling in the aid of any other concern, either for raw material, the manufacturing or the transportation.

Raw gasoline extracted from natural gas and sold in 1915 amounted to 65,364,665 gal., a gain of 53 per cent. over the quantity marketed in 1914. The number of plants for manufacturing gasoline from natural gas increased from 386 at the beginning of 1915 to 414 at the end of the year.

More natural gas was used in the United States in 1915 than in any other year, according to statistics completed under the supervision of the U. S. Geological Survey. The quantity was 628,578,842,000 cu. ft., which exceeds by 6 per cent. the record established in 1914.

T. A. Willson & Co., Inc., Reading, Pa., has been awarded a large Government contract of an unusual character. It is stated to be the first official order ever issued for eye protection equipment for the exclusive use of the country's armed forces. The company's Albex eye protector has been adopted and standardized by the War Department and will soon be a part of the regular equipment of 50,000 troops. The company had previously received an order for about 25,000 goggles for shipment to El Paso and other Southern points. Within a few months about 75,000 enlisted men will be equipped with Willson eye protectors.

What is believed to be the largest natural draft cooling tower so far built has recently been completed at the Anderson, Ind., plant of the American Steel & Wire Co. This tower is of the Wheeler-Balcke type, built by the Wheeler Condenser & Engineering Co., of Carteret, N. J. The tower is approximately 150 long, 50 ft wide and 75 ft. high, and has a yellow pine frame with cypress sheathing and filling. The tower has two chimneys which rise above the cooling stacks and create the air circulation by natural draft. The capacity of the tower is 7300 gals. a minute, cooled from 115 to 85°.

An international airship corporation in Berlin wishes, after the war, to establish an aerial post service (and if this proves a success, a passenger line) between Berlin and Constantinople. A capital of $6,000,000 is estimated as necessary. Its plan is to have the route extend from Berlin to Carlsbad, continuing to Vienna via Budweis, from there to Budapest, and thence on to Constantinople over Sofia. Between these larger cities are to be numerous landing stations, the cities chosen for landings to subscribe for shares.

Finely powdered aluminum forms a part of two of the most destructive explosives known, one of which, ammonal, is a mixture of five to eight parts of ammonium nitrate with one part of aluminum powder and is used to charge shells. It is one of the few explosives which presumably can never be used as a propellant, as its action is so sudden and the force so tremendous that no gun would be able to stand it.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 5

1,196,807. AUTOMOBILE - HORN. WILLARD PENNOCK, Minerva, Ohio.

1,196,849. VACUUM-TUNNEL BOAT CONSTRUCTION. CARL H. FOWLER, New York, N. Y.

1,197,049. AIR VALVE. A. C. MEIXELL, Atlanta, Ga.

1.197,115. SUBMARINE LIFE-PRESERVER. GEORGE EDWARD FELL and GERTRUDE AXTELL FELL, Buffalo, N. Y.

1. A life-saving apparatus, comprising a face-mask, a float containing an air supply-chamber and an air inlet arranged to extend above the surface of the water, a flexible air conduit connecting said mask with said air chamber, a righting weight, and flexible means connecting the weight with the bottom of the float.

1,197,144. AIR-CIRCULATING DEVICE. MOSBY MONTAGUE, Christiansburg, Va.

1,197,217. OIL-BURNER. JOHN E. LIMBACHER, St. Marys, Ohio.

1,197,232. PULMOTOR. JURIAH HARRIS PIERPONT, Pensacola, Fla.

1,197,293. GRAIN-SAVER FOR THRESHING-MACHINES. HOMER F. HUTTON, Jeffers, Mont.

1,197,302. PNEUMATIC CALLIOPE. JOSEPH E. ORI, Bloomfield, N. J.

1,197,371. ENGINE-STARTING MEANS. HERBERT T. HERR, Pittsburgh, Pa.

2. In a device for starting motors, means for introducing air into the cylinder of a motor, a speed governor, and fluid actuated means controlled by the governor for rendering the first named means effective to introduce air into the cylinder and movable out of operative position after the motor has started.

1,197,401. HYDRAULIC PUMP. JOSEPH RITTER, Orizaba, Mexico.

1. In an apparatus of the class described, a distributing tank, a compressor tank adapted to be filled with liquid from the distributing tank under a predetermined hydrostatic head, a siphon from the compressor tank for emptying the same at a rate exceeding the supply to the distributing tank, the hydrostatic head of the shorter arm of said siphon being less than the hydrostatic head under which the compressor tank is filled, a charge-receiving, closed tank positioned above the compressor tank, a conduit for supplying liquid to said tank, the hydro-

static head of said conduit exceeding that of the shorter arm of the siphon, a conduit for transmitting air from the compressor tank to the charge-receiving tank, and a liquid outlet from the charge receiving tank to a height exceeding the hydrostatic head of the shorter arm of the siphon as many times as the volume of the compressor tank exceeds that of the charge-receiving tank.

1,197,410. AIR-PUMP FOR OIL-CANS AND OTHER CONTAINERS. ARTHUR JOSEPH TOOL, Murdock, Nebr.

1,197,490. AUTOMATIC AIR-SANDING DEVICE. JAMES HOGAN, Chicago, Ill.

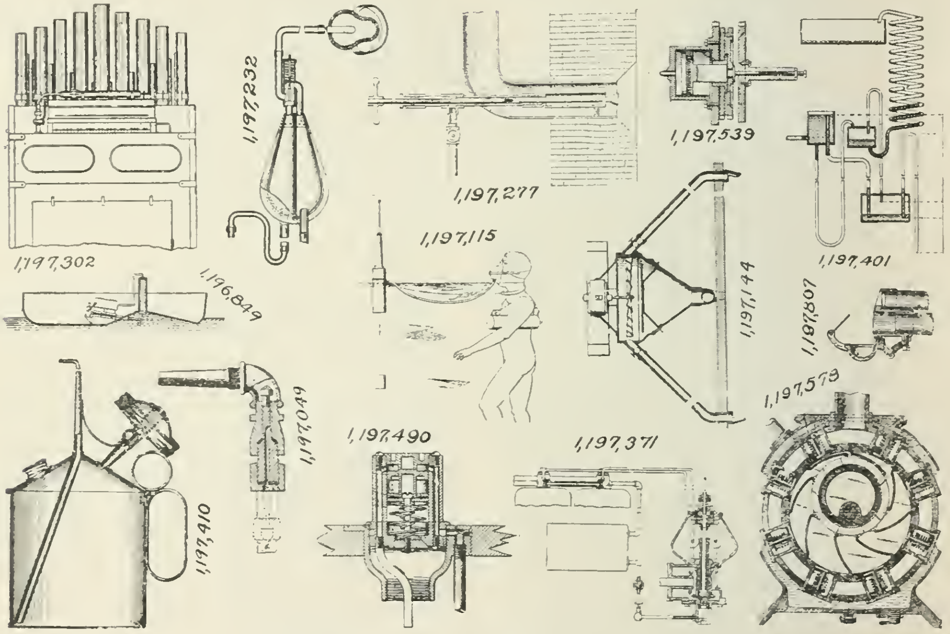
1,197,539. CLUTCH - ACTUATING MEANS FOR AIR-COMPRESSING MECHANISM. AUSBEE PLUMMER, Shaft, Md.

1,197,578-9. ROTARY AIR - COMPRESSOR. HENRY O. JACKSON, Denver, Colo.

inder outside of said submarine to form a communication whereby to permit sea-water to pass into such cylinder, controlling means for controlling the passage through said communication, a holder in said cylinder containing a chemical compound the contact with which by water forms a gas, and gas-receiving means on said submarine connected to said gas generator to be filled by the gas generated thereby when said gas generator is operating, said gas receiving means being spaced from and separate and distinct from said generator so that the water for generating said gas will not enter said gas receiving means.

1,197,653. COMPRESSOR. FRED E. NORTON, Worcester, Mass.

1,197,717. PNEUMATIC MILKING APPARATUS. REUBEN B. DISBROW, St. Paul, Minn.



PNEUMATIC PATENTS SEPTEMBER 5.

SEPTEMBER 12

1,197,596. PNEUMATIC ACTION FOR PIANOS. WILLIAM G. BETZ, Buffalo, N. Y.

1,197,600. OIL - ATOMIZER. JOHN ROBERT BROWN, Vancouver, British Columbia, Canada.

1,197,609. VENTILATOR. THOMAS R. CURTIS, Center City, Tex.

1,197,622. CLASSIFIER. HENRY B. HALLOWELL, Worcester, Mass.

1. In a device of the class described, a casing inclosing a substantially elongated chamber, means for admitting solid matter to be classified to said chamber, means for subjecting the solid matter falling in said chamber to successive blasts of air separated by a period of rest, an air outlet port in the upper portion of said casing, and means for separating the air passing out said port from the particles of solid matter suspended in such air.

1,197,650. MEANS FOR FLOATING OR RAISING FLUID-SUPPORTED OBJECTS. ANTHONY MUSOROFITI, Brooklyn, N. Y.

1. The combination with a submarine, of an emergency floating means comprising a gas generator carried by said submarine and comprising a cylinder, a pipe extending from said cyl-

1,197,771. PUMPING SYSTEM. PHILIP H. SHUE, Denver, Colo.

1. In combination, a series of displacement chambers, and valve-controlled discharge conduits extending from a point adjacent the bottom of each chamber of the series into the next adjoining one, the chambers at opposite ends of the series having respectively a water inlet and a water-outlet and all the chambers of the series being separately connected with a source of fluid-pressure.

1,197,792. AIR-BRAKE SYSTEM. THOMAS HENRY CLAPHAM and JESSE L. MILLER, Pittsburg, Kans.

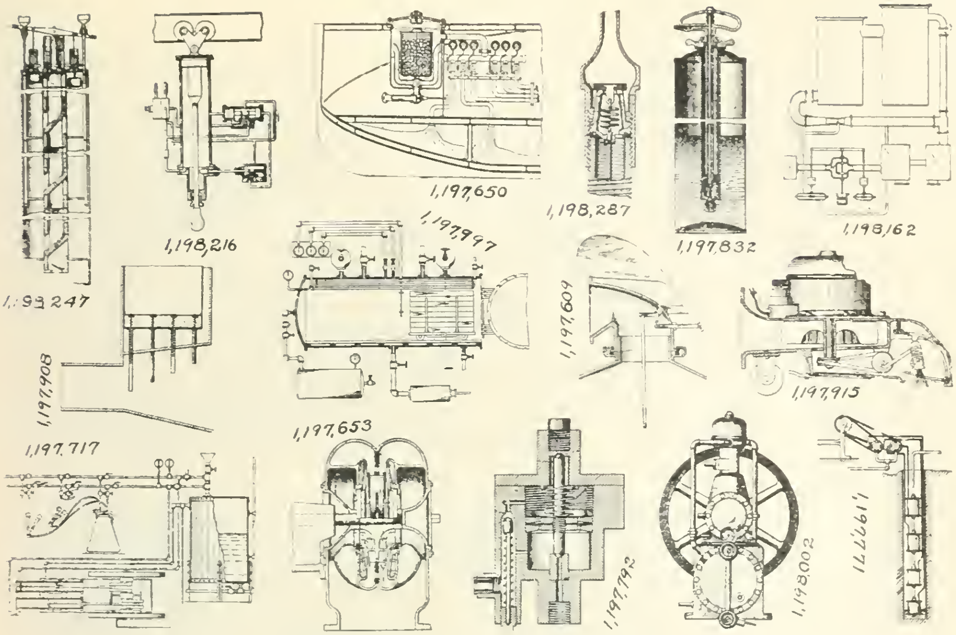
1,197,832. LIQUID-DISTRIBUTER. ARTHUR C. LA MAY, Rochester, N. Y.

1,197,908-9. APPARATUS FOR FEEDING PULVERIZED FUEL. VIRGINIUS Z. CARACRISTI, Albany, N. Y.

1,197,915. VACUUM-CLEANER. CLIFFORD C. DANCE, Denver, Colo.

1,197,997. PROCESS OF TREATING AND PRESERVING WOOD. ANGUS F. BARRY, Kansas City, Mo.

1. The herein described process of treating case-hardened and non-porous wood for the penetration of a preservative without checking of

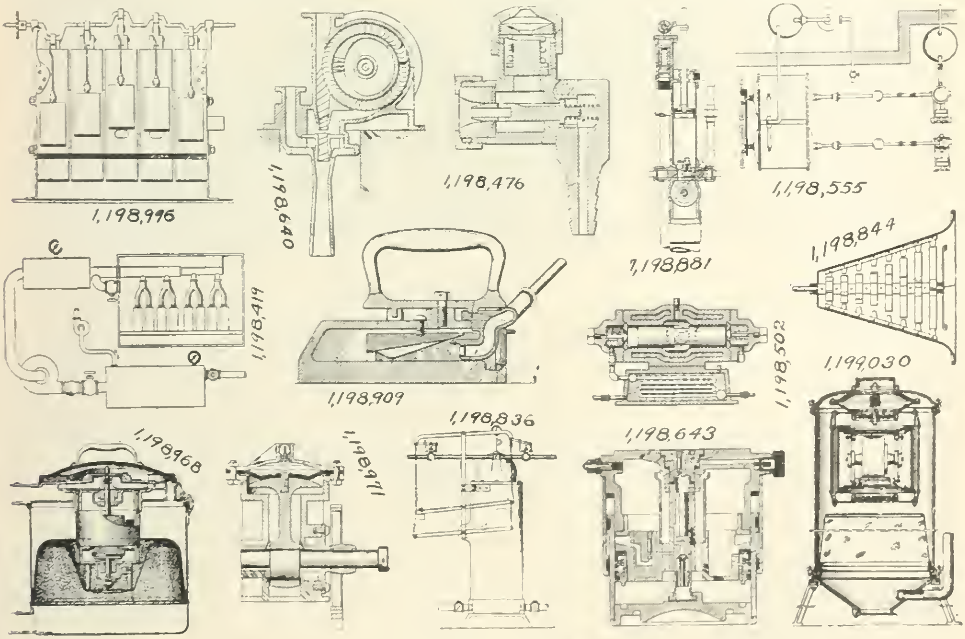


PNEUMATIC PATENTS SEPTEMBER 12.

the wood, which consists in subjecting the wood to a heated vacuum, and supplying a vapor below the boiling point of water for the absorption of the vapor equally by the cellular and case-hardened portions or rings of the wood without breaking the vacuum.

1,198,002. REFRIGERATING - MACHINE. WILLIAM I. BODINE and CHARLES R. SOLOMON, Springfield, Mo.

1,198,125. FLUID-OPERATED TOOL. LOUIS W. GREVE, Cleveland, Ohio.



PNEUMATIC PATENTS SEPTEMBER 19.

1,198,162. REGULATION OF AIR-BLAST IN GAS-GENERATORS. Charles H. Smoot, South Orange, N. J.

1,198,216. FLUID-ACTUATED HOIST. Albert Jarvis Hanson, Portland, Me.

1,198,247. AIR-LIFT FLUID-PUMP. Paul McCoombs, El Paso, Tex.

1,198,266. ROTATION MECHANISM FOR PERCUSSIVE TOOLS. Frederick W. Parsons, Elmira, N. Y.

1,198,287. ATTACHMENT FOR PNEUMATIC-TIRE VALVES. Charles G. Spencer, East Orange, N. J.

SEPTEMBER 19

1,198,419. MEANS FOR CONTROLLING DANGEROUS GASES IN SUBMARINES AND OTHER CRAFT. John M. Clark, Whitestone, N. Y.

1,198,476. PRESSURE-REGULATOR. James H. Pearson, Bloomfield, Ind.

1,198,502. COMPRESSOR FOR REFRIGERATING SYSTEMS. William Wishart and John O. Wishart, Springfield, Ill.

1,198,555. GAS-MIXING SYSTEM. William Wallace Kemp and William H. Van Horn, Baltimore, Md.

1,198,996. PNEUMATIC MOTOR. Theodore P. Brown, Worcester, Mass.

1,199,030. PNEUMATIC PUMPING APPARATUS. Howard Small, Atlantic City, N. J.

SEPTEMBER 26

1,199,201. PNEUMATIC, OR FLUID, CLEANING DEVICE. John Edgar Mote, Indianapolis, and Lewis C. King, Richmond, Ind.

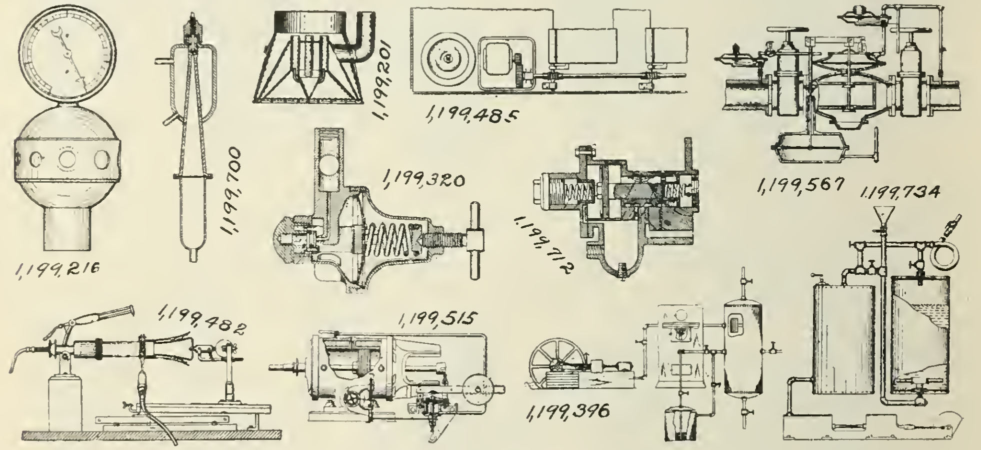
1,199,216. VACUUM-GAGE. Ira H. Spencer, West Hartford, Conn.

1,199,320. PRESSURE-REGULATOR VALVE. Scott H. Tolman, Boston, Mass.

1,199,396. PROCESS OF TREATING AIR. Delbert E. Livingston, Kansas City, Kans.

1. The process of treating atmospheric air which consists in heating the air to be treated, to a high temperature, and raising its inherent pressure, then delivering the air thus heated and without material loss of pressure into a stratifying container, and then drawing off from a high, an intermediate and a low level of said stratifying container, separate portions of the resultant contents thereof.

1,199,482-3-4. APPARATUS FOR THE MANUFACTURE OF DOUBLE-WALLED VACUUM-RECEPTACLES. Oscar Moberg and Edward Hooge, New Britain, Conn.



Pneumatic Patents September 26.

1,198,640. AIR - PUMP. Maurice Leblanc, Paris, France.

1,198,643. HYDRO - PNUEMATIC DEVICE. Richard Liebau, New Haven, Conn.

1,198,777. AIR-BLAST REGULATOR FOR THRESHING-MACHINES. Anton Schmitt, Dubuque, Iowa.

1,198,795. ACETYLENE CUTTING AND WELDING TORCH. Walter W. von Todenwarth, Rahway, N. J.

1,198,836. FLUID-PRESSURE PUMP. Eugene Goileau, Montreal, Quebec, Canada.

1,198,844. ACOUSTIC APPARATUS. Ellsworth A. Hawthorne, Bridgeport, Conn.

1,198,880. ROTARY VACUUM - FILTER. Emanuel Wagner, New York, N. Y.

1,198,881. DISPLACEMENT - PUMP. Elmer A. Watts, Springfield, Ohio.

1,198,968. SUCTION APPARATUS. George E. Stevens, Lynn, Mass.

1,198,909. BLAST SAD-IRON. Samuel Goldstein, New York, N. Y.

1,198,911. ROTARY BLOWER. Max Guttner, Schmolln, Germany.

1,198,945. VACUUM-CLEANER. Sanford A. Moss, Lynn, Mass.

1,198,971-2. PNUEMATIC-TIRE PUMP. Huston Taylor, Chicago, Ill.

1,198,982. AIR-HEATER. Samuel Tully Willson, Brooklyn, N. Y.

1,199,845. VENTILATING TUNNELS. Daniel E. Moran, Mendham, N. J.

1. Means for ventilating tunnels including in combination an outlet flue, valves between said tunnel and said flue, a motor for operating said valves and means actuated by slight variations in the pressure within the tunnel for controlling said motor.

1,199,515. AIR-COMPRESSOR. Edward Wiki, Lucerne, Switzerland.

1,199,567. FLUID-PRESSURE REGULATOR. Raymond M. Kellogg, Mount Vernon, and James K. Crowell, Rye, N. Y.

1,199,700-1. LIQUEFYING GASES WITH A LOW BOILING-POINT. Gotthold Hildebrandt, Spandau-Tiefwerder, near Berlin, Germany.

1,199,712. COMBINED AUTOMATIC AND STRAIGHT-AIR BRAKE. William E. Pomeroy, El Paso, Tex.

1,199,713. VACUUM-CLEANER. William H. Rakestraw, Bloomington, Ill.

1,199,734. PAINTING PROCESS. Clement E. Dunn, Burlingame, Cal.

1. A process of painting which comprises charging a body of air under pressure with paint by passing air through the body of paint, and discharging air from said body of air while so charged with paint against a surface to be painted.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XXI DECEMBER, 1916 No. 12

8175

THE YOUNGEST AND THE OLDEST APPRENTICE.

AVIATION APPRENTICESHIP

The following is taken from the November issue of the Journal of the American Society of Mechanical Engineers. It narrates in the first person some of the aviation experiences of James Hartness, head of the firm, if not all of the firm, of Jones & Lamson, and an ex-President of the Society.

I consider the question of aeronautics one of vital importance to the members of our Society. It is distinctly an engineering problem. The aeroplane at the present stage needs the engineer more than anything else. I am looking forward to a great development in this direction within the next five years, and in view of the importance of the subject believe it should be kept prominently before our members.

One of the results of my experience in learning to fly has demonstrated the fact that it is possible for a man of my age to reach a point where he can handle a machine with reasonable safety. The Canadian Government does not take any men for training for war service who are over 23 years old. Some authorities think that good flyers cannot be made out of timber that is over 35 years of age, and, as a matter of record, I believe few men have learned after passing the fiftieth mark. I am, as you know, 55 years old, and I have gone through my course at the Wright school and passed the examination for aviator's certificate which is issued under the rules of the Federation Aeronautique Internationale, with the authority of the Aero Club of America. I have had in all over 60 flights and have been intrusted with a machine without a pilot for six flights.

I became interested in the matter of flying when taking my first flight in a Zeppelin at Leipsic during our joint meeting with the Verein deutscher Ingenieure. This was followed when the opportuntiy offered by a flight in a Burgess-Duenne seaplane at Marblehead and about half a dozen flights in the Heinrich tractor at Garden City. Then I entered on a course of instruction with the Wright school which was established at Garden City last spring. The usual length of time for the regular students runs from one to two months, but my lessons were drawn out over a longer period because I spent alternating weeks at home.

I am told that the usual course of instruction in other schools begins with familiarizing the student with the working of the engine and the various controls of the aeroplane and the general behavior of the machine while on the ground. A number of runs, at first short and then longer, are taken in the machine on the ground without rising into the air. This is followed by jumps, during which the machine is allowed to rise from the ground for short distances. After that actual flights of gradually increasing duration are attempted.

But the instructor, Mr. Howard Rinehart, did not follow that method. He started the student first with a "joy ride." After that he allowed the student gradually to assume the control. The art of getting the machine off the ground and alighting was left to the latter part of the course. In my own experience, the order of my acquisition of the various elements of the art of flying might be summarized as follows:

I first gained the ability to keep the machine in lateral balance in flying straight away; then followed the use of rudder and warp for turning in a large circle; next the smaller circles in both right and left turns, making figure 8's, and during these flights, which vary from 2 to 10 min., I was permitted gradually to assume more and more of the control during the get-away. But the art of controlling the angle of climb and the art of landing were the last and the most difficult.

Barring unsteady air currents and machine troubles, the amateur's danger seems to lie chiefly in stalling in getting away and in flying, and in the general problem of landing.

The stalling is due to trying to climb too fast, for this retards the speed of the machine through the air and renders the control ineffective.

In steady air the experienced pilot is able to make his landing by swooping down and nicely leveling his course just to clear the ground, and let the wheels touch at the slowest speed at which the controls are effective.

The machine used is shown in the photograph. It is a slow-flying Wright biplane known as their Type B. It is practically the same as the Wright machine of eight years ago, with the wings warped to effect the banking and lateral control. The course was completed, however, with another machine, in which both wings were rigidly braced and flaps or ailerons were used for the lateral control.

In these machines, the dual control with instructor and student sitting side by side, the conditions seem ideal, for each may see what the other is doing. This not only makes it possible for the instructor to direct the student by prearranged signals, but it also leaves no doubt in the student's mind of the extent of control exercised by the instructor. In the machines in which the two sit in tandem position, the student is not always sure that the instructor has not gently changed the control.

The machines were driven with a 35-h. p. Wright engine. I have no accurate data as to the speed, but I understand it would get away from the ground at less than 30 miles an hour and could not fly over 45 miles an hour. This is a training biplane, different from the high-speed tractors which the Wright Company is building for other purposes. The slow-speed machines fly so close to a stall that they must be handled properly or they go wrong. A stall of the machine does not necessarily indicate a stall of the engine. It simply means that the aeroplane loses its speed in the air below a point at which the controls are effective. Then it is liable to side slip or do any one of the number of things that invite trouble.

The type of control used is a modification of the Wright system which brings it nearer to the Deperdussin control, called "Dep" control, but the Wright does not use the foot control rudder. For lateral balance the "Dep" control uses a wheel located about the same as an automobile steering wheel, only in normal position it is vertical instead of inclined. Turning the wheel to the right or left tips the machine in similar directions. The wheel is pivoted to the frame, on which it may be moved forward and back, and this motion controls the elevator which raises or lowers the course of the machine. The Wright rudder is a lever on this hand wheel which is similar to the throttle of an automobile.

This letter may seem very elementary, especially to the aeronautical members of the Society, but in view of the newness of the art I think we should not hesitate to set forth the subject in a way to benefit those who have not entered into it.

I am sending a photograph showing the two seats of the aeroplane occupied by the youngest and oldest members of the class. Mr. Mott from Winnipeg is the younger man. He is one of the many Canadians who have come to this school to train preparatory to entering the British aviation service.

In extracting oil from peanuts in a hydraulic press they are subjected to a pressure of 6,000 pounds per square inch.

ROUGHENING A CONCRETE FLOOR FOR RESURFACING

BY CHARLES A. HIRSCHBERG

A change in plans for dry dock No. 1, Balboa terminal of the Panama Canal, necessitated the resurfacing of 113,120 sq. ft. of concrete floor. It was considered advisable to chip the floor before placing the mortar finish on the old concrete, and a more rapid means was sought than that of the hand chisel and hammer.

Two standard Ingersoll reciprocating tripod drills, air operated and of 3⅝-in. cylinder diameter, were called into use. The tripods were altered as shown in Fig. 1. At the end of each tripod leg an extension was welded, as shown at *A,* a hole being drilled at *B* to take the trunnion of the hand-made fork *C,* which carried an axle at *D.* An old pully wheel *E* was mounted on each axle.

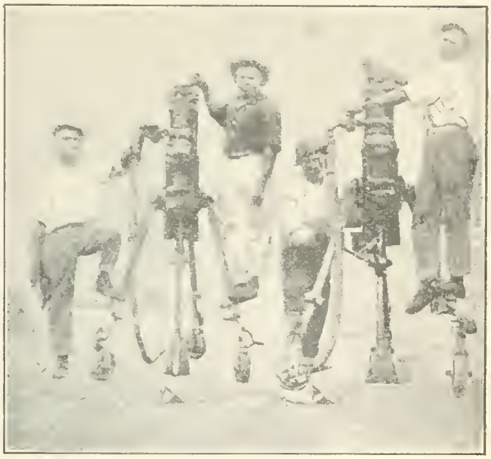


FIG. 1.

The complete apparatus is shown in Fig. 2. The drilling machine is thrown back slightly, so that the crossbit strikes the concrete at an angle, presenting only bit corners to the surface as the steel rotates. With each blow struck, the recoil tends to move the machine and tripod, thus materially assisting the helper in keeping the machine moving. The bits used were of the standard cross type, 8 in. in diameter. It was found that one machine, operated by two men, did as much work in 8 hours as 50 men could do by hand, and all the work was therefore performed with the two machines. Acknowledgment for the data is made to Z. T. Stagg, Jr., who was in charge of this work.—*Eng. News.*

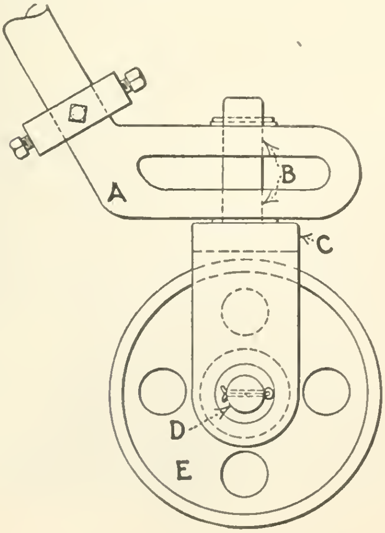


FIG. 2.

BLASTING WITH LIQUID OXYGEN IN SALT MINES

The war has advanced a type of blasting which was experimentally tried years ago, as soon almost as liquid air and oxygen became commercial articles, but which had so far not found practical adoption. Cartridges were charged with charcoal, and the carbon was impregnated with liquid oxygen; the ignited carbon then burned with explosive energy. But there were, of course, very great difficulties, which may be summed up in the statement that liquid air does not admit of being stored in closed vessels and evaporates rapidly when kept in open vessels.

In 1915 experiments with liquid oxygen cartridges were energetically taken up by the saltworks at Winterhall, acting in conjunction with the famous potassium salt mines of Stassfurt and other localities, and considerable progress has been achieved, according to an illustrated article by Dr. Heberle, of Berlin, published in the journal *Kali* of January 15 April 15, 1916. "Kali," we may add, means potash. The cartridges are simply made of texture paper, or cardboard, and are charged with soot or charcoal, mixed sometimes with other ingredients, or with kieselguhr and petroleum. The soot has answered well. A cap of fulminate of mercury is generally added for ignition; this cap should not be rigidly connected with the cartridge, to facilitate impregnation of the carbon. The Marsit cartridge does not need any cap. Ignition is by fuses or by electric wires; Dr. Hecker is said to have devised suitable ignition devices which do not require the instantaneous ignition of all the cartridges in a circuit. Impregnation of the pre-cooled material may be effected either by pouring the oxygen into the cartridge through a tube of filter paper (Baldus and Kowatsch), or by immersing the cartridge in the liquid; the latter procedure is preferable. The oxygen should be of high concentration, 99 or 97 per cent. The immersion of a cartridge takes from 5 to 25 minutes.

The experiments seem, at any rate, to have established several important facts. A cartridge can be so impregnated that it will still explode 10 or 15 minutes after being tamped in its hole; means have even been found by which cartridges could be impregnated at the surface and be taken down and used as much as three hours later. This is not considered important for salt mines, because the general conditions there demand that many appliances should be kept below. But the fact that not more than two men are required to look after up to 20 blasts would be important. Glass vessels or bottles were first tried for the transport of the liquid oxygen; but some unpleasant experiences were met with, and the transport vessels and immersion vessels are better made of metal. A hole may require 2 liters (2 quarts) of liquid oxygen. The immersion cylinders at Winterhall have a diameter of 25 centimeters (9.8 in.) and 38 centimeters (15 in.) height; but big cartridges, 32 centimeters (12.6 in.) in diameter, are sometimes used, and as many as five cartridges are fixed in one hole of a depth of 150 centimeters (59 in.) This great depth of the boreholes is characteristic of salt blasting. Heberle estimates that one blast would cost $3.50, counting materials and labor. That would not be cheap, and he adds, moreover, that conditions may be less favorable elsewhere than they are at Winterhall. The actual dearth of explosives during war time may be a factor in these attempts. But there has been a good deal of experimenting on oxygen cartridges in this country as well, of course, and the point is to adapt the extra plant to the special conditions and to utilize it fully. Sawdust, we see from another German publication on mines, has not answered well as an absorbent for oxygen in cartridges, and it was observed in a limestone quarry that the percentage of carbon monoxide present in the air went up to 0.15 after firing two of these shots. That would be a grave matter.

PNEUMATICS TO TEACH PHONETICS

The Arabic, which boasts three separate sounds resembling the English letter *h,* lacks the equivalent of the letter *p*. In consequence *p* and *b* are often confused. The late venerable Dr. Bliss of the Syrian Protestant College once entered a classroom where a native teacher was trying in vain to teach a student the difference between *p* and *b*. Dr. Bliss undertook the case. Gathering up some chalk dust in his hand and holding his hand to his lips he spoke to the student. "Do you see this dust in my hand? When I say *b* I do not expel my breath, and the chalk dust stays where it is. But when I say *p* I blow the dust all away." He did. He blew it all over the enlightened youth.

STEAM HAMMERS SHOULD BE AIR HAMMERS

The substance of the present article, both text and cuts, is adapted from the November issue of *Machinery* where it appeared under the title of "Some Notes on Steam Hammers," by James Cran, and it is here reproduced as of pertinent interest to the readers of Compressed Air Magazine because the hammers spoken of are more entitled to be driven by air than by steam, for the good of all concerned.

As a matter of fact, large numbers of what would normally be called steam hammers are now driven by air, both isolated hammers and hammers in extensive groups, as in shipbuilding establishments and elsewhere. No change in design or construction and no expense is involved in applying the air drive. It is only necessary to connect the hammer with the air supply which is maintained in practically every establishment and there is no use for an exhaust pipe. The advantages are immediate, self-evident and indisputable. The air driven hammer is always and instantly ready to go, requiring no warming up and no working off of the waters of condensation. There are no scalding drops or streams squirting around, no hot surfaces to avoid touching. The lubricant stays on the surfaces so that little is required and at infrequent intervals. There is absolutely no expense for steam or power except for actual work done and at the instant it is done. Where air is ever tried for steam hammers it stays on the job and there is no return to steam.

Two types of steam hammers [let us hereinafter call them air hammers] are in general use, namely, single- and double-frame hammers, either of which may be of the open-frame order. Open-frame hammers are not provided with guides to keep the ram and the upper die in alignment with the anvil and lower die; they have, however, a much heavier piston-rod, either of round section with one flat side to keep it from turning, or of hexagonal form working through a long gland of corresponding shape. While the alignment of open-frame hammers is not as perfect as those provided with guides, the former can be used for a much wider range of work, owing to the fact that they are accessible on three sides, having no guides to come in the way of irregular shaped forgings, and the operator has an unobstructed view of the work. The more common type of air hammer with guides is not so convenient for the majority of work, but is better suited to making duplicate parts in quantities, as special dies can be kept in almost perfect alignment.

The single-frame air hammer shown in Fig. 1 differs but slightly from most of the others of this type in general use. It is built to run automatically and the hammer will continue to strike the same force of blow as long as the air pressure remains the same after the throttle valve is opened and the controlling lever set in its quadrant. The length of stroke and the force of the blow can be increased or diminished within certain limits after the controlling lever has been set, by changing the position of the throttle lever to admit more or less air to the cylinder. The automatic attachment on air hammers performs the same function as the eccentric movement on a plain slide valve engine, opening and closing the ports that admit steam to the cylinders, the difference being that the ports of an air hammer are opened and closed by a reciprocating instead of a rotary mechanism. On the back of the ram inside the frame there is a shoe or slide upon which a cam lever attached to the fulcrum of

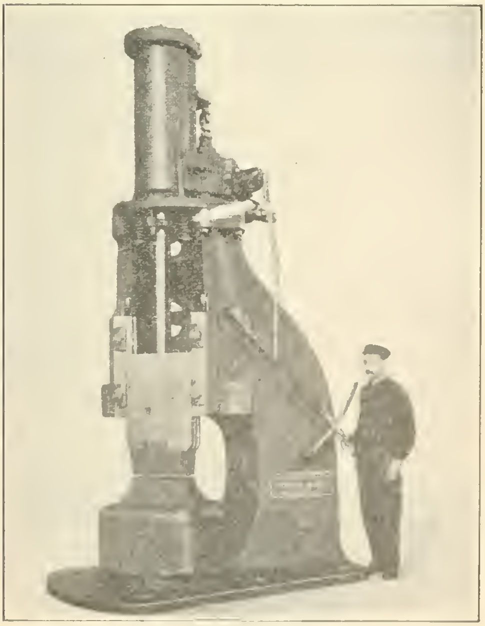


FIG. 1.

the controlling lever works, a short lever on the end of the fulcrum shaft being attached to the valve stem by a connecting-rod at the back of the hammer for the purpose of controlling the vertical movement of the valve.

KEEPING UP EFFICIENCY

The efficiency of this type of hammer depends to a considerable extent upon the correct setting of the valves. When the valve is adjusted so that the hammer (when running automatically) will take just sufficient air at the lower port to raise the ram, and will open the top port to its full capacity with the shortest possible travel of the valve, the hammer will work at its maximum efficiency and will hold pieces firmly between the dies by throwing the throttle wide open and setting the controlling lever at the lowest point of the quadrant. After a certain amount of service, air hammers frequently get into such a condition that they will not hold pieces firmly between the dies on account of lost motion through wear of the various working parts that connect the controlling lever with the valve stem. The reason for this is that the valve does not rise high enough to completely close the exhaust opening. The remedy for a condition such as this is to shorten the valve stem, which is adjustable, in order to compensate for wear on the connecting-rod and levers.

While most air hammers in general use are constructed to run automatically, this does not mean that all of them can be so used or without a separate operator to manipulate the valve, as only the smaller sizes, say from 250 to 600 pounds' capacity, can be run to advantage with a foot-lever connected with the throttle valve. A man doing small work can use the foot-lever without inconvenience after the controlling lever has been set for the desired force of blow, but he is obliged to have the free use of both feet when doing heavier work, and this usually calls for a wider variety of blows than can be had through a purely automatic system of control.

SIZE AND CAPACITY OF AIR HAMMERS

It is a difficult matter to state definitely the capacity of a hammer as regards the size of work which it can handle to advantage; there are so many conflicting factors which affect the situation that it is impossible to give anything like a rating that will cover all conditions. The following data, which are given out by a well-known builder of air hammers, may be safely used as a basis for estimating the size of hammer needed for a given piece of work:

Diameter of Stock (Round or Square)	Size of Hammer, Pounds
3½ inches	250 to 350
4 inches	350 to 600
4½ inches	600 to 800
5 inches	800 to 1000
6 inches	1000 to 1500

A rule given in *Machinery's* Handbook is:

"Multiply the area of the piece to be forged in square inches by 80;" the result is the required falling weight in pounds. For example, a forging 4 inches square would require a falling weight of 4 × 4 × 80 = 1280 pounds. This rule gives the weight considerably heavier than that recommended in the foregoing.

One of the most common mistakes made in selecting an air hammer is getting one which is too light for the work on which it is intended to be used. When a light hammer is used to draw down heavy stock to smaller size, the effect of the blows does not penetrate to the center of the material, and as a consequence the outside is drawn more than the inside. When this happens, it will be easily discernible by examining the pieces, which will be found to be concave on the end. When the hammer is of sufficient size, the ends of the pieces drawn down will be convex, showing that the effect of the blows has penetrated to the center of the work.

If it were possible to operate air hammers at all times with a full stroke and air pressure at, say, 100 pounds per square inch, it would be comparatively easy to give a rating for the different sizes, but as the variation in both air pressure and length of stroke must be taken into consideration, the problem is more difficult. It will be readily seen that when a full length stroke of the hammer can be used in working under a full head of air, the results both from momentum and air expansion are very much greater in proportion than when a short stroke is used. Some of the information given out by the manufacturers of air hammers is rather misleading to those not familiar with forging work. For example, an occasional forging may be made on a much smaller hammer than would be used for making the same piece in large quantity production. While forgings such as a 6-inch pinion or a short

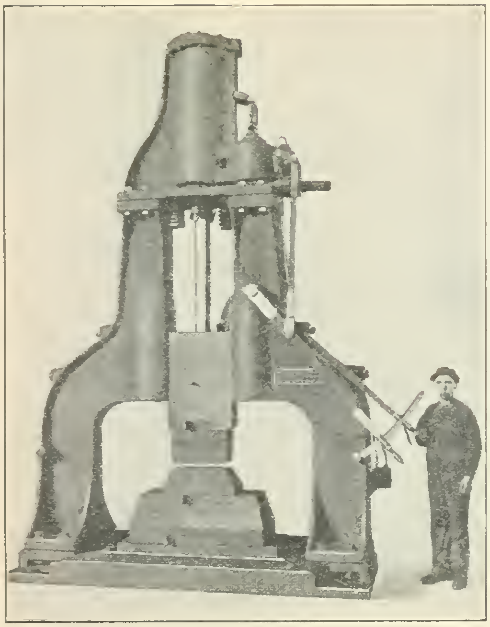


FIG. 2.

shaft can be made on an 800- or 1000-pound hammer, one of 1500-pound weight would be required to produce the same pieces in large quantities. To get the maximum output of 6-inch axles which must be forged from much heavier stock than the dimensions imply, a hammer from 6000 to 8000 pounds' capacity will be required. From the foregoing it will be seen that the selection of a hammer is dependent largely upon the work for which it is intended, and judgment must be used in regard to production and other factors mentioned.

Double-frame hammers differ from those described only in the shape of the frame, which is made in the form of an arch, the sides of which act as guides for the ram, the anvil being in the center, as will be noted by referring to Fig. 2. The open-frame air hammer shown in Fig. 3 is a machine that merits more attention than has generally been given to it, owing to the fact that hammers of this type are to be found to some extent in nearly all factories where the making of forgings forms an important part of the work.

This hammer is simple in construction, as it has fewer working parts than any other machine of the same kind. By referring to the illustration, it will be seen that it is provided with only one lever, which performs the double duty of opening the throttle and controlling the stroke. The first movement of the lever upward opens the throttle and also the lower port to the cylinder, which admits the steam to raise the ram. Thus it will be seen that the lever and ram work in unison and that when the lever is raised, the piston and ram rise, while for the downward stroke the lever is lowered, although not to the extreme end of the guide in which it travels.

A hammer of this kind cannot be operated automatically, but this is an advantage in some ways, because after a blow has been struck, the ram will not start on the return stroke until the lever has been raised. This prevents rebound and a second short stroke which often follows a full blow, delivered by hammers having an automatic attachment when attended by a poor operator. Another feature of this hammer is the absence of safety buffers which are intended to prevent the piston rising too far in the cylinder. This is taken care of automatically by a number of small ports near the top of the cylinder, which are arranged so as to admit just sufficient air to act as a cushion. The piston when raised beyond a certain point moves automatically until the air pressure under it has been released. The operation of air hammers is a knack acquired by practice, and young boys generally become the most expert in this work. Science does not enter into the operation in any way.

FOUNDATIONS

In conclusion, a little may be said in re-

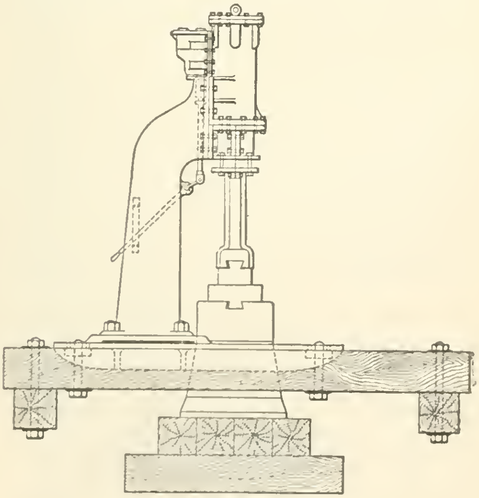


FIG. 3.

gard to foundations. While most air hammer manufacturers send out drawings and specifications to cover this part of the subject, the nature of the ground upon which the hammers are to be installed should always be taken into consideration. In sand or clay soil it is advisable to have the foundation of concrete up to within 6 inches of the anvil base and covered with a wooden cushion to bring it up to its full height. When a rock bottom is found, the pier of crossed timbers usually specified will give satisfaction.

"GASSED" IN THE TRENCHES

This is what "gassing" is like. The description is by one who knows what it is from practical experience. "In the morning I was listening in the gallery that had been blown on the Friday, and as it had been pretty free from gas I never took a canary to test the atmosphere. I must have been down about three-quarters of an hour when one of my men joined me, and in about another quarter of an hour we came up. Directly I came to the fresh air I felt rotten, and said to my man, 'Air is very bad.' 'Yes,' he said, 'I don't know how you stood it so long, sir.' I got back to my dug-out and was very sick, but B—— thought I was only bilious. I had to survey a point in two shafts in the afternoon, and went out in a half-fuddled state to do it. I know I went down the gassy shaft and another, and I just remember getting back to my dug-out and again being very sick. B—— still thought I was bilious, and by that time I was incapable of telling him that I was gassed, but fortunately our reliefs came in at 5, and one of the officers saw what was the matter, and put me straight on to a stretcher, sending me off to a dressing station. By that time I was 'out,' and dimly remember being mauled about and told to 'Breathe, you old fool, breathe!' I remember protesting that I was quite happy, but under pressure tried to heave up my chest and take a breath. It's a most pleasant sensation, really, and there is no pain at all. Only they would annoy me by sticking evil-smelling things to my nose and mouth. Ulitmately they pulled me round, and sent me off to the second dressing station, and thence to rest camp, hospital and 'Blighty,' much against my will. To show you how bad the gas was at that part, when our company was handed over to another one, a few days before I got this time, they, of course, carefully explained how bad the place was for CO gas, and were rather laughed at for their trouble. But two nights after they took over, they lost one officer and five men, not through an explosion, but through breaking into a 'pocket' which still held gas from an old explosion."

AMERICAN ENGINEERS SINKING A SHAFT IN NORWAY

BY LLOYD D. COOPER*

At the Lökken mine, operated by the Orkla Grube-Aktiebolag, Norway, to increase the output a shaft was to be sunk to the depth of 1,200 feet, and a depth of 85 feet was reached by the Orkla company when a contract was closed with the E. J. Longyear Co., of Minneapolis, Minn., for the completion of the work.

Under this contract it was agreed to maintain an average rate of 66 ft. per month. The crew for the work was secured on the Marquette and Menominee ranges in Michigan and reached Lökkens Verk early in July, 1915. Shaft sinking, however, was not started until Aug. 5.

The Orkla company had installed a surface plant for the shaft-sinking operations. This consisted of one motor-driven Ingersoll two-stage air compressor, one motor-driven Hammer single-stage air compressor, two motor-driven hoisting engines having a hoisting speed of 300 ft. per min., and a 7½-h. p. Sturtevant ventilating fan. This equipment was used by the Longyear company in the consummation of its contract, with the addition of a No. 5 Leyner drill sharpener, which was brought over from America. The drilling equipment consists of 15 BCR430 jackhamers with 30 sets of 7/8-in. four-point steel.

The shaft is 12x18 ft. outside of timbers, divided into five compartments which will provide for two skips, two cages and the necessary pipes and ladderways. The rock through which the shaft has been sunk is known as gabbro. It drills easily except through seams of low-grade ore, which occur frequently.

Temporary sheaves are supported on timbers set in the concrete foundations for the shafthouse, which itself will be built of reinforced concrete, as well as the machine shop

---

*Chief Engineer and later Manager for E. J. Longyear Co. at Trondhjem, Norway.

and engine house which are at present under construction. The spoil is hoisted in two 30-cu. ft. buckets, guided by crossheads and is used for filling a railroad grade about 1,000 ft. from the shaft.

The water encountered is handled by one Eureka 10x4½x10-in. outside-packed plunger pump on the 200-m. level and one 7x3-in. piston pump which is carried down on the timbers as the shaft is sunk. A small pump is used in the bottom, and all pumps are driven by air. A large sump on the 200-m. level was made by building a concrete wall across the drift, and most of the water that comes into the shaft above this level is caught by it. It was planned to pump from the 200-m. level with an electrically driven vertical centrifugal pump capable of handling 135 gal. per min. to a height of 650 ft., but this was found unsuitable and was replaced by an air pump.

The air compressors were of sufficient capacity to maintain 90 lb. pressure, but an unusually early winter caused a serious shortage of water at the power plant just at the time when it became necessary to pump with air, so that from December, 1915, until March, 1916, pressures of from 55 to 80 lb. prevailed. At times only four drills could be used while the pumps were running. As the depth from which the water had to be pumped increased, it was found necessary to run an air line to the compressors at the Lökken mine and use additional compressed air from there. The air line in the shaft is a 4-in. pipe, to which is attached a header with twelve ¾-in. nipples for the machine and pump-hose connections.

The work has been carried on in three 8-hr. shifts with an average for the year of 8.5 men per shift. The personnel is under the supervision of a mining captain and consists of the following men working an 8-hr. shift: 3 foremen, 30 miners, 1 timber foreman and 4 timbermen. The following worked a 10-hr. shift: 2 timber framers, 2 blacksmiths, 2 pipemen and 1 electrician. In addition, the following worked a 12-hr. shift: 2 pumpmen, 3 hoisting engineers, 2 compressor men and 9 landers.

THE METHOD OF WORKING

The first 260 ft. of the shaft was supported with round timbers spaced 7 ft. apart without lining. Soft ground was encountered which made it necessary to change the method of timbering, and 7x7-ft. square sets, spaced 6 ft. on center and supported on timber bearings at 100-ft. intervals have been used. The shaft is lined with 3-in. plank, and the skip roads are separated from the rest of the shaft with 3-in matched lumber. All timbering, with the exception of putting in the stringers, is done without interfering with the sinking operations.

A strong timber stage, having doors through which the buckets pass, is hung below the bottom set, and on this the timbermen work. This stage is supported by four wire cables wound on hand winches in the tunnel and is lowered as the stage is sunk. The skip-roads are covered at the tunnel level by two pairs of doors, balanced with counter-weights, which are closed after the bucket is hoisted, preventing any rock from falling back into the shaft.

Under the usual arrangement of drilling, which of course was varied somewhat as the character of the ground changed, 14 sink holes were drilled and with them were blasted the four corner holes from the last round above, using du Pont delay electric exploders. After the rock from this blast had been hoitsed, 46 squaring-up holes were drilled, the inside holes being started down in the sink. The holes were found to break deeper when drilled in this way, and it more than compensated for the extra time taken in drilling the round in two parts. On the second blast 15 to 20 holes were shot and the mucking continued until water appeared in the bottom of the shaft. The remaining holes, with the exception of the four corner ones, were then blasted so that the pump was not taken down until after the last blast.

After blasting, the smoke was drawn out through a 10-in. pipe. This method required from 30 to 40 min. to clear the shaft so that work could be resumed.

THE RATE OF PROGRESS

During the year of sinking from Aug. 5. 1915, to Aug. 4, 1916, the cuts averaged 5.7 ft. in depth, breaking 1,231 cu. ft. of rock each with 494 lin. ft. of drilling. The average drilling speed was 4.4 ft. per machine-hour, which includes all the time from the completion of the mucking until starting to charge the holes. The 14 sink holes are frequently drilled by 10 machines in one hour. The holes averaged 7.6 ft. in depth. Of the actual working time in the shaft, 30% was spent in drilling, 59% in mucking and hoisting and 11% in blasting.

During this period the miners worked 7,217 shifts removing 206,496 cu. ft. of rock, or 28.6 cu. ft. per man per shift. In this time the shaft was sunk 904 ft., or at the rate of 75.3 ft. per month. As the shaft had previously been sunk 85 ft. by the Orkla company, the total depth on Aug. 4, 1916, was 989 ft. In connection with the sinking, stations were cut at the 200-m. and 300-m. levels, requiring 49 shifts of 8 hr. each; in October, 1915, the compressor house was destroyed by fire, causing a loss of 38 shifts, while labor troubles in May and June delayed the work 30 shifts. The actual sinking time (making no allowance for delays) was therefore 276 days, or a sinking rate of 85.3 ft. per month.

As the Norwegian laws prohibit Sunday work, requiring a suspension of 28 hr., no work was done from 6 p. m. on Saturdays until 10 p. m. on Sundays. In the spring of 1916, however, permission was obtained to work until 11 p. m. Saturdays, thus permitting all the men to work six full shifts a week.

At the date of writing (Aug. 22, 1916) there still remained approximately 210 ft. of shaft to be sunk and two stations to be cut.

The following permanent equipment is to be installed when the shaft is completed: Two 500-h. p. Hammer air compressors, direct-connected to 300-kw. motors (each compressor will have a capacity of 2,600 cu. ft. per min.); one hoisting engine for men and materials, having a 10-ft. drum with a speed of 1,200 ft. per min. and driven by a 280-h. p. motor; one hoisting engine operating two 5-ton skips at a maximum speed of 1,450 ft. per min. and driven by a 700-h. p. motor. (Both hoists will have automatic speed-regulating devices attached to the indicators to prevent overwinding or excessive speed at the start); one electrically driven plunger pump handling 135 gal. of water per min. to a height of 1,200 ft.; one 30-h. p. ventilating fan; two 36x42 Buchanan rock crushers, which will be installed underground. —*Eng. and Min. Journal* (Abridged).

GASOLINE CAUTIONS

Gasoline should be kept and used only in small quantities, and used only by experienced employees who realize the danger in using this volatile fluid and know how to handle it safely. Gasoline should be handled in small safety cans, equipped with safety gauze and safety stopper. Gasoline is exceedingly volatile and will vaporize when exposed to the air at any temperature down to 15 below zero. This vapor is nearly three times as heavy as air, and when mixed with the proper quantity of air becomes violently explosive. The vapor will ignite from any open flame, even from a spark of static electricity from a human body, a spark from an emery wheel, or from a sufficiently heated surface. The gasoline vapor, being heavier than air, will naturally seek a lower level, and if confined where there is poor ventilation, will sometimes remain in an explosive condition for months.

AIR-BALANCED HOISTING ENGINE

[The title above which we here reproduce with an interesting article from a recent issue of *Power*, must strike the reader as not adequately descriptive of the matter as a whole. It will be seen that the compressing of air not only balances the descending skip but the air so compressed is put to economical use in connection with the steam employed for hoisting. The arrangement is ingenious, but there are those who will question whether all the additional apparatus required and the complication of function may not "cost all that it comes to."]

At the Franklin Junior copper mine of the Franklin Mining Co., at Boston, Mich., is a combined steam and air hoist for handling the skip in the single shaft that is 3,700 ft. deep. Usually a double-compartment shaft is used at copper mines with two skips, one being at the top when the other is at the bottom of the shaft, and each counterbalances the other. It is the opinion of some that a single-compartment shaft on long lifts is advisable, but in order to operate a single-shaft hoist economically some kind of balanced hoisting engine must be used. Although this air-balanced hoisting engine is more complicated than the ordinary type, it utilizes the power developed by the descending skip by using air that is compressed during such periods.

The hoist is a horizontal, twin steam-cylinder engine. Both steam cylinders have Corliss valves and are next to the crossheads. The air-compressor cylinders are immediately back of the steam cylinders. Extension piston rods pass through the head end of the steam cylinders, to which the air pistons are attached, thus forming a combined hoisting engine and air compressor.

While lowering the skip, the piston in the steam cylinders runs free, the weight of the skip (1,400 lb.) and the cable being sufficient to rotate the hoisting drum and operate the compressor pistons. While hoisting, the air pistons run free. Full control of the hoist is afforded by means of suitable levers convenient for handling by the engineer, who operates from an elevated platform. As the skip descends the shaft, its speed is governed by the engineer, who controls the amount of air compressed, and he can govern the work performed in the air cylinders between the limits of no load and full cylinder capacity.

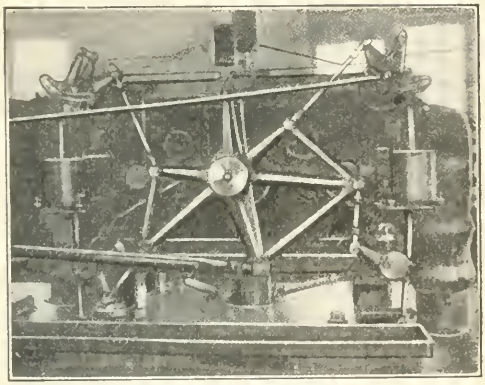


FIG. 1.

The air-compressing cylinders (Fig. 1) are each designed with four valves of the Corliss type. Both bottom valves admit free air to the cylinder; the two upper ones are for regulating the air capacity and are controlled by the engineer while lowering the skip. Both are fitted with releasing mechanism and dashpots. In the heads of the compressor cylinders are spring-loaded discharge valves through which the air is delivered under pressure. When the two upper valves are open, the passage from the cylinder is direct to the air-inlet pipes through a chamber on top of the cylinder, and no air can be compressed.

The operation of these valves is as follows: When the skip is being lowered and the air piston is moving toward the end of the cylinder, if the regulating or top valve is open, the air in front of the piston will be forced back into the inlet pipe. Should the engineer trip the valve at any point of the skip travel in the shaft, the dashpot will close and the air left in the cylinder will begin to compress until a pressure is reached sufficient to open the discharge valve, when it passes to the storage tanks.

The farther the engineer moves his lever the more air will be compressed and the resistance on the air pistons will be increased. In this way the air cylinders regulate the speed of the hoist while lowering the skip. Ordinary steam-operated brakes are used for controlling the speed for the landing of the skip. On the steam cylinders the exhaust valves are arranged to be released from their connections and remain wide open and stationary so as to enable the engine to run free while lowering the skip. Upon reversing the direction of rotation for hoisting, they are hooked up again. This releasing and hooking-up mechanism is operated by a small steam-thrust cylinder. As the operating gears of the cylinders are connected to the reversing gear of the hoisting engine, the exhaust valves are either released or hooked up as the case may be, when the engineer reverses the engine, without any other attention on his part.

All air compressed by the machine is mixed with the steam from the boilers, and the mixture is used in the steam cylinders of the hoist during the hoisting period. The mixture takes place in three cylindrical drums, each 10 ft. in diameter and 32 ft. long. As shown in the plan view (Fig. 2), a 12-in. steam pipe runs from the three 200- h. p. locomotive-type boilers to one end of the receivers. From the opposite end of the receivers a 16-in. pipe is run to the throttle valve of the engine. There is also a 12-in. discharge pipe from each air compressor, which connects with the 16-in. line that carries the air to the receivers while lowering the skip and air and steam to the steam cylinders while hoisting. In the 12-in. pipe between the boilers (which carry 125-lb. pressure) and the receiver tanks, there is a reducing valve set to maintain about 65 lb. pressure on the receivers.

The operation of the receivers, tank and reducing valve is such that when the skip is at the top the receivers are under a steam pressure of, say, 65 lb., and when it is lowered into the mine the air compressors begin to discharge compressed air in to the receivers, where the air is mixed with the steam which they already contain. This pressure increases until by the time the skip reaches the bottom of the mine it is 95 lb. in the receivers. When starting to hoist, the pressure gradually decreases until 65 lb. is reached as the engine uses up the stored air produced by the lowering of the skip. When this pressure is reached in the receivers, the reducing valve opens and steam from the boilers goes to the engine to complete the remainder of the hoisting travel. When the hoist stops, the pressure in the tank is built up to 65 lb., and upon the next lowering of the skip the operation is repeated. The skip is hoisted about 1,000 ft. with air pressure and the remaining distance with steam.

The general dimensions of the hoist are as follows:

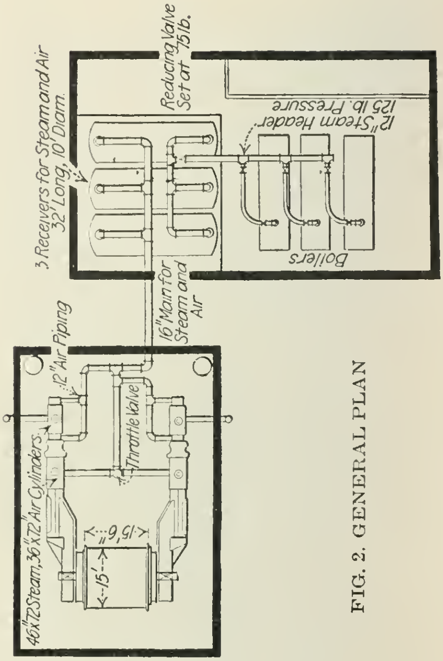

3 Receivers for Steam and Air 32' Long, 10' Diam.
Reducing Valve Set at 75 lb.
12" Steam Header
125 lb. Pressure
Boilers
16" Main for Steam and Air
12" Air Piping
Throttle Valve
46"x72" Steam, 36"x72" Air Cylinders
15' 6"
15'

FIG. 2. GENERAL PLAN

Diameter of steam cylinders	46 in.
Diameters of air cylinders	36 in.
Stroke of all cylinders	72 in.
Diameter of piston rods	7½ in.
Diameter of hoisting drum	15 ft.
Length of hoisting drum	15 ft. 5 in.
Capacity of drum, rope	5,130 ft. 1⅝ in.
Weight of skip	14,000 lb.
Weight of rock	20,000 lb.
Velocity of skip hoisting	1,500 ft. per min.
Velocity of skip lowering	2,000 ft. per min.
Shaft dip	47 deg. from horizontal

Only three levers are required to handle this hoist—a throttle, a reversing and a brake lever, the same as on other types of hoists. In this instance, however, the throttle lever usually stands in a vertical position when the hoist is stopped. If the engineer pushes it from him, it operates the throttle valve; if he pulls it toward him, it acts on the regulating valves of the air cylinders.

The idea of using this type of hoisting engine originated with R. M. Edwards, general manager of the Franklin Mining Co., of the Lake Superior copper district, and it was built by the Nordberg Mfg. Co.

POWER FROM VOLCANIC HEAT

The greatly increased cost of coal in Italy has stimulated the search for other and more economical sources of energy. A novel method of obtaining power consists in the utilisation of the internal heat of the earth in a volcanic district. A thermo-electric power-house is already in operation at Larderello, some twelve miles from Volterra, and producing about 10,000 h. p. The idea of using the available heat was first put into practice by Prince Ginori Conti in 1903. At Larderello steam issues from the earth in jets, and the Prince first utilised the steam as a jet impinging on a bucket wheel. Later he used the steam in the ordinary way in a reciprocating engine coupled to a dynamo. Encouraged by the results, he made use of a small part of the steam issuing from one of the largest jets at a pressure of 75 lbs. per sq. in., and by this means obtained some 40 h. p. The steam from this jet issues at a temperature of 160 deg. C., (320 F.) and at the rate of 11,000 lbs. per hour. The general results obtained were quite satisfactory, except that it was found that acids present in the steam rapidly corroded the engine. In the meantime, while these experiments were going on, borings were made to discover new sources of steam, some of which gave good results, especially one which gave out steam at a pressure of 30 to 45 lbs., and at the rate of 55,000 lbs. per hour. In 1912 a turbo-alternator of 300 h. p. was installed, and was used to light the borax works at Larderello. Matters were at this stage when the war broke out, and the immensely increased cost of coal (now quoted at $50 per ton) gave an impetus to further development. The Prince decided to make a great step forward. The well-known engine builders, Messrs. Tosi, of Legnano, are now providing three steam turbines each of 5,000 h. p., coupled to alternators of 3,000 kw. The turbines are provided with surface condensers. The natural steam, however, instead of being used directly in the turbines, is used to heat multitubular boilers giving a pressure of 23 lbs. per sq. in. Two of these 5,000-h. p. groups are already installed and in operation, and the third will shortly be added. The current is transformed up to 36,000 volts and transmitted along five different lines to the towns in the neighborhood.

COST OF OPERATING AIR COMPRESSORS FOR RAILWAY TRAINS

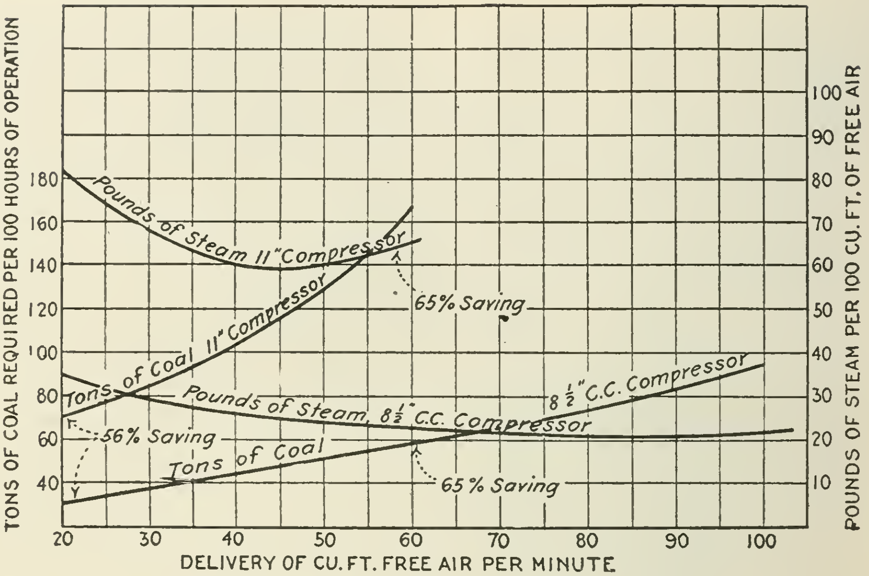
We have recently received inquiries concerning the comparative cost of operating the 9½ and 11 and 8½ ins. Cross Compound air compressors, and these questions were relative to the comparative coal consumption under what was stated as average conditions, and the average condition would be something exceedingly difficult to determine. There is a wide variation among the different railroads as to steam and air pressures employed as well as the length of trains, amount of leakage from the brake system, and grade conditions or frequency of applications of the brakes.

Another thing that must be remembered is that the conditions under which an air compressor operates are somewhat peculiar in that there are no brake applications at the time the engine is being worked to its maximum capacity and that when the brake applications are made the engine throttle is shut off and some of the steam consumed by the air compressors would otherwise be wasted through the safety valves, that is, there is a possibility of such being the case.

Another phase of the situation is that it is impossible to work up any accurate statements for average conditions, since the amount of water that will be evaporated per pound of coal varies widely according to the type of coal used, some coal will evaporate approximately 5 lbs. of water per pound of coal while other grades of coal will evaporate from 10 to 11 lbs. of water per pound of coal.

As a comparison of the amount of steam consumed by the three different types of compressors for doing an equivalent amount of work or delivering an equal number of cubic feet of free air for a specified length of time, when operating against 100 lbs. air pressure with 200 lbs. steam pressure, the 9½-in. compressor consumes approximately 68 lbs. of steam per 100 cubic feet of free air delivered, while the 11-in. compressor 65 lbs. and the 8½-in. cross compound 24 lbs. per hundred cubic feet of free air delivered.

From estimates that have been made covering the actual cost of operation of air compressors in steam railroad service, it appears that the cost of operating the 9½-in. compressor is about 185% more per hundred cubic feet of free air delivered than the 8½-in. compressor. However, the cost in dollars and



COMPARATIVE STEAM AND COAL CURVES.

For various rates of air delivery of the 11" x 11" x 12" and the 8½" C. C. compressors at 185 lb. steam pressure and 110 lb. air pressure. Compressor speed controlled by 1¼" governor set at 110 lbs. Coal required computed on the basis of 7 pounds of water evaporated per pound of coal and 1,000 hours continuous service.

Example: At 50 cu. ft. free air per minute 11" compressor uses 129 tons of coal and 8½" C. C. compressor uses 52 tons of coal. 129 — 52 = 77 tons saving. 77/129 = .60 or 60% savings.

cents would depend upon the various conditions mentioned.

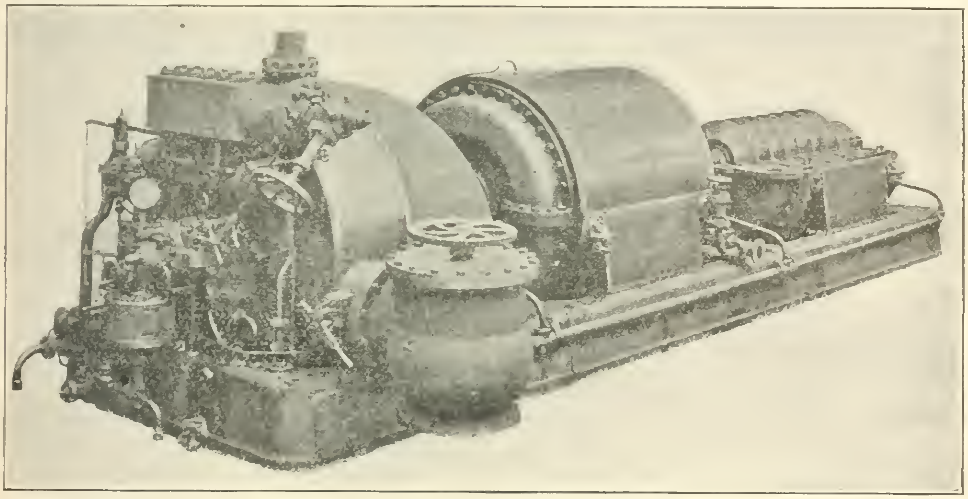
There is a considerable amount of information given in a paper read before the International Railway Fuel Association, at Chicago, Ill., last May, in which the cost of air compressor operation was dealt with, but this was mostly from a viewpoint of cost of brake pipe leakage, and it certainly emphasizes the importance of the elimination, so far as possible, of brake pipe leakage from a standpoint of economy in coal consumption, saying nothing whatever of the possibilities from improved brake operation.

On a 100-car train, an 8 lb. per minute leakage from the brake pipe is assumed, and with such a train 3,621 lbs. of coal will be consumed during a trip of 12 hours duration through brake pipe leakage alone. From tests made with trains averaging 68 cars, two 11-in. compressors in average condition, it was found that the coal consumed by the compressors was 7,500 lbs. per trip of 115 miles made in 13 hours.

From another point of view, the cost of train pipe leakage in fuel with compound pumps, it was found that this would fluctuate around .00015 cents per car mile, or 15 cents per thousand car miles. On one particular road, the total car mileage, freight, passenger and work train, was 798,607,253 which at 15 cents per thousand car miles means an expenditure of $119,791 per year to maintain brake pipe leakage.

As a comparative cost of the different compressors in this operation, it was found that for the same amount of work in maintaining brake pipe leakage, the cost with the 11-in. compressor would be $299,477 per year, and with the 9½-in. compressor the cost would be $359,373.

The diagram shown here, obtained from tests made by the Engineering Department of the Westinghouse Air Brake Company, shows a comparison of the amount of steam and coal consumed by the 11-in. and 8½-in. for a given amount of work per hour. That is, it is intended to demonstrate the economy in coal consumption that is made possible by the use of the cross compound compressor which uses the steam from the high pressure cylinder into the low pressure cylinder for work before it is exhausted to the atmosphere or rather uses the steam twice, as is meant by the expression compounding. With the cross compound air compressor, however, compressed air is also utilized to assist to a certain extent in the operation of the compressor, that is, in the final stage of compression, air compressed from the low pressure air cylinder assists in the operation of the low pressure steam a high pressure air piston.—*Railway and Locomotive Engineering.*



HIGH PRESSURE TURBO AIR COMPRESSOR.

HIGH PRESSURE TURBO AIR COMPRESSORS

Turbo-compressors supply an interesting example of the rapidity with which in modern machine construction any new type of machine is brought from the initial stages to a practical and serviceable form. The turbo-compressor, which is to-day constructed in single units of the largest output, has been developed within a period of about ten years. Compressors of this type have been built in sizes ranging up to 60,000 cub. ft. per min. of free air, up to a pressure of 170 lbs. per sq. in. gauge when running at a speed of 3,000 revs. per min. This output corresponds to an input of 12,000 to 13,000 horse-power, measured at the shaft.

The outstanding advantages of turbo-compressors as compared with reciprocating compressors may be summarised as follows:—(1) The floor space occupied is much smaller, the capital expenditure is less, and the overall efficiency is higher. (2) Much lighter foundations are required, and the turbine drive permits of the condenser being placed immediately below the turbine with a consequent reduction in the length of the eduction pipe. (3) No internal lubrication of the compressor is necessary, and since with turbine drive forced lubrication is provided to all bearings, a considerable amount of oil is thus saved and less attention is required. (4) The turbo-compressor permits of the use of exhaust steam from winding, hauling, rolling-mill engines, etc. (5) The supply of air from a turbo-compressor is free from oil, which is a *sine qua non* in the case of certain chemical processes. (6) The air delivered by a turbo-compressor is continuous in supply, and not pulsating as in the case of reciprocating machines.

The attainment of high efficiency in a turbo-compressor lies in the correct acceleration with least losses, and the careful conversion of energy of motion into energy of pressure. Another vital point is the provision of adequate cooling during the compression process. The multi-stage construction employed in building turbo-compressors permits of the advantages of cooling, and it is possible to approach the isothermal pressure curve more closely than in a piston compressor with staged compression and intermediate cooling.

In the British Thompson-Houston Company's turbo-compressors, the air, inhaled through a suitable duct, passes through a number of stages in series, the stages being divided over two casings since the number of impellers is too large to be carried on one shaft. The work done in compressing the air in each set of stages is approximately of equal value. The impellers are constructed of high-tensile strength steel and are forced on to the shafts by hydraulic pressure, the fit between the impeller and shaft being provided by means of special bronze rings embedded in the bore of the impeller. By means of this construction loose fits, with consequent vibration, are an unknown quantity. The vanes are attached to the impeller discs in such a manner that trouble due to loose vanes is an impossibility.

The flow of air through the two sets of impellers is so arranged that the end thrust of one set of impellers is eliminated by that of the other set of impellers, the two shafts butting together between the bearings to be found in the centre pedestal situated between the two casings. The connection between the two shafts for driving purposes is through a flexible coupling of the claw type, and the coupling between the turbine and the compressor is also of the same type.

The two casings are connected together beneath the floor level by means of piping, and if a comparatively low temperature of air at the delivery of the compressor is required, an inter-cooler may be connected in at this point in place of the pipe mentioned above. By this means the temperature of the air at the delivery of the machine can be reduced down to approximately 136 deg. Fah. with an inlet cooling-water temperature of 50 deg. Fah., the final air pressure in this case being 120 lbs. per sq. in. gauge.

After the air has passed through an impeller, it passes through a set of guide vanes in the diffusers by means of which a high efficiency is obtained, and by the suitable design of these vanes a very silent operation of the com pressor.

The air is effectively cooled as it passes through the casing. The water jackets surround the impeller chambers, the diffusers and the return passages, whilst the hollow partitions separating the return passages from the diffusers are also supplied with circulating water. The water is made to follow a very circuitous path through both the water jackets and hollow partitions, and by this means an effective circulation from the point of view of transference of heat is maintained. No internal water-tight connections have to be made between the upper and lower halves of the casing, as all the water connections are external. Cooling blades of cast-iron are attached to the hollow partitions between the stages for the purpose of increasing the cooling surface.

The sealing of the openings in diaphragms, through which the shaft passes from stage to stage, and also in the covers of the casings, is effected by a patented construction consisting of an internally-grooved ring split into four parts and held together by leaf openings. The ring fits in a groove turned in the diaphragm which prevents it moving inwards on to the shaft, but at same time allows it free movement outwards. This effectually guards against any risk of damage due to inaccurate assembly and enables fine shaft clearances to be used without danger.

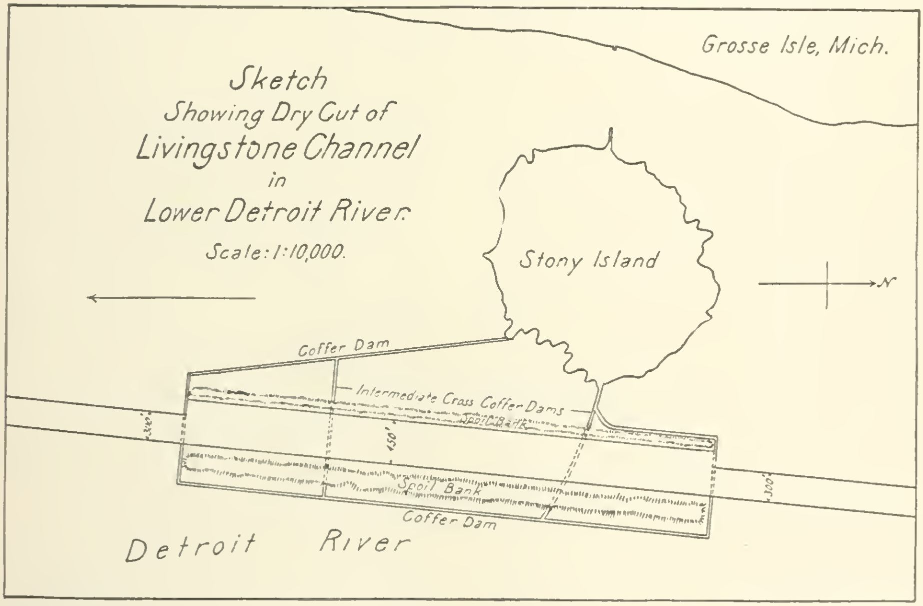
In order to maintain a constant pressure of air at the delivery of the compressor, independent of the quantity of air being used, the speed of revolution of the turbine and compressor is varied. This effect is produced by means of a piston moving in a cylinder which is under the action of the delivery air pressure from the turbo-compressor. The piston operates the pilot valve which controls the supply of steam to the turbine. In actual operation it is found that this type of governor will maintain the pressure at the delivery of this compressor constant to within 2 to 3 lbs. per sq-in., with a variation in output on the delivery mains from practically full load to no load and *vice versa*.

The compressor shown in the photograph reproduced herewith is driven by a mixed-pressure turbine of the Curtis type. The machine is in operation at a well-known colliery in the Midlands (England) and receives its supply of exhaust steam from winding, hauling and other engines at the pit brow. The capacity of the machine is 5,000 cub. ft. of free air per min., up to a pressure of 80 lbs. per. sq. in. gauge. It has also an overload capacity of 6,250 cub. ft. of free air per min. at the same delivery pressure. The normal speed of rotation is 4,600 revs. per min. at full load The machine is not provided with an inter-cooler, as a low temperature of air at delivery was not specified.

The compressed air is employed in coal-cutting, operating haulages, ventilating, etc. Although the demand for compressed air in the case of this machine varies very considerably and ranges at times from 5,000 down to 1,500 to 2,000 cub. ft. per min. in less than 30 secs., the variation in pressure of the air at the delivery of the compressor does not exceed 2 lbs. per sq. in.

DRY EXCAVATION OF LIVINGSTONE CHANNEL

Among the most important and valuable of the works of the national government for the improvement of our internal waterways was the Livingstone Channel in the lower Detroit River. This deep channel was excavated through solid limestone rock and affords a direct and safe passage for the immense vessel traffic of the great lakes. It is said that more vessels and a greater tonnage pass through it than through any other waterway in the world, and the $10,000,000 which the work of improvement cost was money well spent.



The entire scheme was to develop the channel to a depth of 22 feet at a low water stage for 300 feet width and about 6 miles in length at its north end, and for 800 feet width and about 5 miles length at its south end to deep water in Lake Erie. Throughout the greater portion of the length the work was carried on by the usual subaqueous method of rock and earth excavation, the equipment consisting of dredges, drill-boats and other floating plant, and this work was described in the technical journals at about the time of its completion four years ago.

For a length of about one mile, however, abreast of Stony Island near the north end, the channelway was surrounded by earth dams, the enclosed area being then unwatered and the excavation made by the dry method. Within the area enclosed by the dams there was very little earth covering the rock and the depth of rock cutting varied from 12 to 18 feet. The rock was a Dolomite limestone of Silurian formation, lying in strata of from 1 to 4 feet thick. All the work of constructing the dams, unwatering the enclosed area and making the necessary excavation was done by contractors (Grant Smith & Co. and Locker) in an unusually expeditious manner, a description of the operations by Mr. C. Y. Dixon, Assistant Engineer appearing in a recent issue of *Professional Memoirs*.

The contractors leased Stony Island, which was privately owned, and used it as a base of operations. On the east shore of the island there was installed an air compressor plant which was substantially housed, also there were erected about forty buildings, including repair shops, warehouse, store, rooming house, mess hall, school house and a number of dwellings for employees, the work continuing for about forty months.

EQUIPMENT

The plant and equipment was as follows: Air compressor plant, small locomotive with eight flat cars on about 1½ miles of track, seventeen pumps of various sizes, fourteen portable tripod drills, five traction drills, three channelers, three steam shovels and three cableway conveyors. Also, there were used for building the dams two derrick boats, five flat scows and three launches. The number of employees averaged about 250.

The total length of channel surrounded by dams was about 5,800 feet, and the inclosed area had an average width of about 1,200 feet, being about 160 acres. This area was divided into three parts, each surrounded by dams. Each area was unwatered as soon as the inclosing dams were completed, and after the unwatering of the end areas the intermediate dams crossing the channel were removed.

CENTRIFUGAL PUMPS AND AIR LIFTS

The work of unwatering the central area of 2,800 feet length was begun October 5, 1908, by the use of two 12-inch centrifugal pumps and an air lift consisting of forty-eight 8-inch pipes. These pipes were suspended at an inclination of about 30 degrees from the vertical and extended from about 1 foot above the water surface nearly to the bottom of the river. Compressed air admitted at the lower end of the pipes caused the water to be discharged from the pipes into a sluiceway, through which it flowed into the river. This air lift was very efficient until the water was lowered from 12 feet depth to about 7 feet depth when the air was forced up through the water without raising it, and the air lift was then discontinued. Further pumping was done as required by the progress of the excavation. The leakage through the dams was small, and after the initial unwatering the pumping was mainly that due to rains and melting snow.

CHANNELING

Prior to blasting the rock to be excavated, that along the side lines was cut to the required depth by channelers, which were air driven and three in number. Each channeler was operated by three men working in eight-hour shifts, usually for sixteen hours per day.

DRILLING AND BLASTING

The rock to be excavated between the channeled side lines was broken by drilling and blasting. The number of small portable tripod drills used varied from five to fourteen. Also, there were used at different times five traction drills mounted on trucks. These traction drills were equipped for "pinning up," so as to be rigid when in operation, and with a special device for washing out the sludge, making them much more efficient than the small portable tripod drills. All drills were air driven, and each was operated by two men working in eight-hour shifts, usually for sixteen hours per day. The holes were usually drilled at the corners of 6-foot squares. In blasting the rock two grades of dynamite were used, 60 per cent and 40 per cent., the latter near the side lines reducing the danger of shattering the channel face of the wall.

EXCAVATION

The material was excavated by steam shovels and deposited in skips or iron baskets of about 5 cubic yards capacity, which were carried by cableway conveyors about 400 feet to points back of either side of the channel and there dumped. There were used three steam shovels and three cableway conveyors. The conveyors were operated by compressed air, and they were suspended from two towers about 100 feet high, one on each side of the channel. As the work advanced the cableway towers were moved forward on tracks in order to keep abreast of the steam shovels. Following the steam shovels, a gang of laborers cleared the bottom of all loose rock, which was placed in the skips by hand. Then the elevations of the highest points of the bottom were obtained by the use of a surveyor's level to insure the required grade being made, and, where necessary, high points of rock were removed by further drilling and blasting and by hand labor. Thus, as the work advanced it was left completed. The steam shovels and cableway conveyors were operated in eight-hour shifts, usually for twenty-four hours per day. The number of men in each shift with steam shovel and cableway conveyor was 3 on steam shovel, 2 on cableway conveyor, 1 bell-boy to give signals for operating cableway, 1 man to hook skips to cableway, and 1 foreman and 6 laborers excavating by hand labor, being a total of 14 men.

GENERAL USE OF COMPRESSED AIR

Compressed air was the principal motive power for pumps, channelers, drills, cableway conveyors and shops. The compressor plant consisted of two units, one of about 700 horsepower and one of about 300 horsepower. Usually, during working hours, the compressor plant was operated to full capacity; but at night when only a portion of other plant was at work, and on Sundays when only the pumps were in use, one compressor working at low speed furnished ample power for all purposes. There was therefore frequent opportunity for repairs to compressors and they were kept in excellent condition throughout the entire period of the work. This plant was operated by men working in three 8-hour shifts per day. The force of each shift consisted of 1 engineman, 2 oilers, 1 fireman and 2 laborers. The air was delivered to the main line pipe under a pressure of 90 pounds per square inch, at a temperature of 230 degrees F. The main line pipe was 8 inches in diameter and about 7,500 feet long, and it was placed on top of the dam surrounding the inclosure. At frequent intervals along the main line pipe, distributing pipes from 1 to 6 inches in diameter conveyed the compressed air to points on the work where needed. The pipe lines required the constant attention of about four men in laying and shifting distributing lines, in stopping air leakage and in drawing off moisture. During cold weather fires were necessary at frequent intervals under the pipes to prevent moisture from freezing and stopping the flow of air. Also, for greater efficiency, the compressed air passed through reheaters before use in the operation of channelers and cableway conveyors.

SAVING OF TIME AND COST

The cost of this improvement was about $600,000 less than it would have been by the usual subaqueous method, as indicated by prices named in proposals for the work. In addition to this saving, the work was done in about 75 per cent. of the time that would otherwise have been required, and vessels using this channel are much less liable to injury, because of the smooth vertical sides and nearly even bottom. Livingstone Channel was formally opened to navigation on October 19, 1912. Since that date this route has been used by all downbound freight steamers—all upbound vessels being required to use the channel formerly improved near the Canadian shore at the mouth of Detroit River.

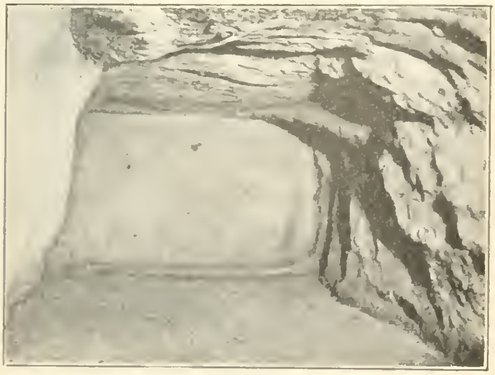
It is safer to solder your gasoline tank when full than when empty.

CEMENT GUN IN POSITION.

THE CEMENT GUN TO PREVENT ROOF SLACKING IN COAL MINES

The extremely hot weather during the past summer has been the cause of considerable roof slacking in the various bituminous fields, to a greater degree than has been the case for several previous years. This has been so marked in numerous instances as to cause the focusing of attention on some method of protecting these surfaces against the attacks of air and moisture. It seems pertinent, therefore, in this connection to call attention to the satisfactory results that have been obtained in two instances through the use of the cement gun.

Early in 1914, L. M. Jones, mining engineer in charge of the Coal Mining Department of the Bureau of Mines, used a cement gun to line the two slope entries at the Experiment mine, near Bruceton, Penn. His reason for



GUNITED ROOF AND RIBS.

making this lining was that when it was determined to use this mine for the purpose of making explosion tests with anthracite dust, the anthracite operators objected because they felt that there would be present a large amount of bituminous dust which would affect the conditions.

The inner end of the main slope and the air entry, for about 360 ft. of each, were therefore coated with "gunite" and brushed fairly smooth to insure against the possibility of bituminous dust finding a lodgment there. This left the two entries, each of which is about 1,300 ft. long, with an entrance lining of concrete for 300 ft., an untreated length of 650 ft. and a gunited portion as noted above. This work was completed early in the fall. The explosion tests were started about Oct. 15 and have continued at the rate of about three explosions per week ever since, except during the summer months, or between about May 15 and Oct. 15.

At the time that the guniting was done, there was marked indication of slacking taking place along the sides of the entry, and along the uncovered portion these now exist to a considerable degree. In the covered portion, however, there is no indication of slacking having advanced at all, as the sides are entirely unbroken and there has been no scaling. There are, as would be expected, a number of places where slabs of the mortar have broken, away from the roof, owing to the heavy explosions. These have been patched by hand, as the bureau has not had a cement gun available for such work.

When the bureau finished with the cement gun at Experiment, it was sent to the H. C. Frick Coke Co. at Mount Pleasant, Penn., and was used by the superintendent, James Mack, for a similar purpose. Considerable trouble had been experienced at this time with the roof and sides of the entry approaches to the shaft level slacking, and a coating varying from 1-16 in. to 4 in. or more was shot on. This protection has been so successful that no further work of any character has been necessary in two years along the coated portions.

In coating the surfaces of the entries at Experiment, Mr. Jones kept accurate costs of the work as in column following.

Air Course

Size of entry	5.9 (height) by 9.15 ft.
Lineal feet coated	358
Square feet coated	8,100
Cost of labor (including supervision)	$172.64
Material	114.38
Total	$287.02
Cost per square foot, labor	$0.0213
Cost per square foot, material	.0141
Labor and material, per square foot	$0.0354
Cost per foot advance	$0.76
Cost per square yard	.319
Speed	11¼ sq.yd. per hr.

Entry

Square feet coated	8,925
Lineal feet coated	425
Cost of labor	$232.38
Materials	161.81
Total	$394.19
Cost per square foot	$0.0441
Cost per foot advance	.928
Cost per square yard	.397

The depth of covering ranged from about ¼ in. to 4 in., but Mr. Jones advises that it would be best to use a minimum of ½ in. and states that it is not necessary to build out the low places to a continuous surface, as was done by the bureau because of explosion conditions.

Inasmuch as this work, if as successful as the above experiences would indicate, would save an annual expenditure in some cases running into thousands of dollars, besides meaning the saving of an original cost of timberwork and the guarding against many operating delays, it would seem that these experiments warrant the careful consideration of every mine superintendent and engineer in the country.—*Coal Age.*

DUST, SAND, WIND

BY DR. H. LIPSCHÜTZ

When a rock has crumbled into sand and dust the fine particles become the sport of the winds unless they are solidified by natural or artificial means. The sand is carried along by the wind over the ground in heavy clouds. The fine dust, on the other hand, is whirled high in the air, coming to rest weeks later. The finer the grain of sand or dust the farther it is carried by the wind. Dust 1-64 millimeter (.00061 in.) in diameter may be blown around the entire earth. The largest sand-grains the wind is capable of carrying have a diameter of 2 millimeters (.078 in.) With a fineness of 0.125 to 0.25 millimeters (.005 to .01 in.) the wind can carry it more than a kilometer (⅝ mile). The North German flying sands range in diameter from 0.2 to 0.5 millimeters (.0078 in. to .0196 in.)

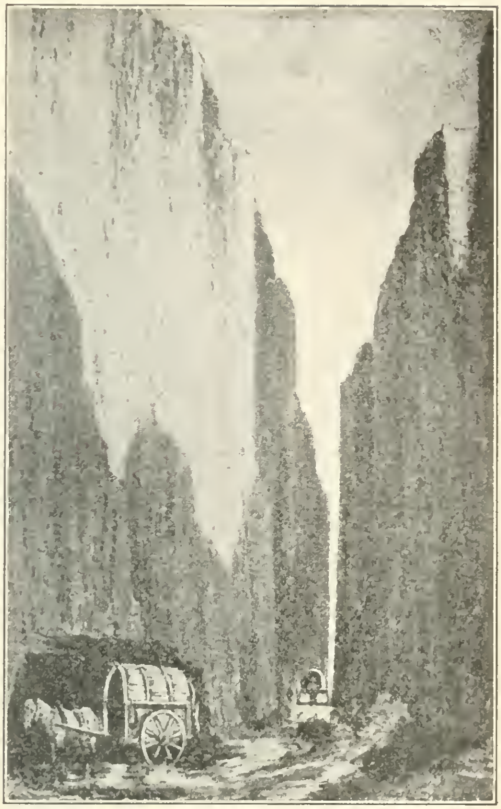
Flying sand may be formed in different ways.

It can come from every rock containing quartz and from every sedimentary stone containing sand. Thus we find in Egypt and Tripoli many deserts where the flying sand arises from the weathering of sandstone. . . . The waves of the sea constantly bear to the shore new material composed of fine quartz sand. After being dried . . . it is driven landwards by the wind and heaped into long hills near the shore, known as dunes. If the dunes do not become solidified the wind constantly drives them farther inland, with the result that everything they pass becomes covered with sand.

Just as by the sea, so can flying sand be found on the shores of great inland lakes. Thus, for example, we find dunes on the shores of the Aral and Caspian Seas. Loose masses of sand piled up into hills by the wind in the interior are known as land dunes. They are frequently formed by the sand of rivers. Thus the river dunes on the left shore of the Volga, near Kasan, penetrating far into the Kirghis Steppe, are formed of river mud which has lost its particles of clay. We observe this on a greater scale near the Central Asiatic rivers, Amudarja and Syrdarja. These rivers carry enormous masses of sandy mud, almost filling their beds. Borings in the bed of the former have shown as great a depth of mud as 23 meters (75 ft.) Under such conditions the banks are naturally flooded as soon as the water rises, and the sandy mud is spread over a wide flooded area. After the water falls the hot wind quickly dries out the mud and blows away the dust and lighter particles of mud, that is, the clayey substances. The pure sand remaining is piled into dunes by the wind and driven on. In this way the deserts Kysilkum and Karakum have been formed. Seven per cent. of our total land area has been taken possession of by loose sand. In this manner desolate deserts have been made of localities once fertile and blooming, e. g., in Mesopotamia, and stretches of the Nile Valley. Land may be preserved by protective measures, such as damming, irrigating and planting. The planting is usually of trees.

A thoughtless removal of protective plant covering may even to-day cause the formation of sand deserts in the interior.

Let us now follow briefly the destiny of the fine dust. According to Richthofen every desert is a storm center. Since damp earth cannot be carried by wind, consequently all dust must wander on the wings of the wind until it has left the desert behind, i. e., till it has found moist earth protected from the action of the wind, or has been washed down by rains. We can scarcely form a conception of the monstrous masses of dust drifting in air currents. On the Red Sea the dust-filled winds coming from the African deserts form the well-known dust-fogs, which are so dense as to be dangerous to vessels. The regions bordering deserts, in which the dust is largely deposited, are called steppes. Here the winds are less strong than in the desert; moreover, the ground is fructified by more frequent precipitation. These conditions tend not only to cause a depositing of the dust, but its retention on the ground. According to Richthofen permanent settling and holding down of the dust is in general made possible only by a covering of vegetation. The deposits made in this way cover immense regions. They are known under the name of loess.


CUT IN SCHAN SI, CHINA.

They are of greatest extent in China. They also attain usually a great depth, in China as much as 700 meters (2,300 ft.) (The illustration shows a road through the loess formation in the province of Schan Si.) In Germany such deposits are found in the Rhine and Main valleys, and on the northern edge of the Central Mountain chain of Saxony. In the Rhine valley the depth is 30 meters. Such regions are generally dry where they form steppes. The precipitation suffices to cause a luxurious growth of grass, but not of forest. Hence, the steppes are mostly treeless. The famous Russian black earth is nothing but such deposits, whose humus content comes from the decaying vegetation of the steppes. Black earth is formed where the precipitation is greater than on the real steppe. However, it is treeless. Extensive regions of black earth are found in the United States and in the Argentine. They are very fertile because composed of fine particles of clay, and this clay holds the nutritious substances, whereas soil composed of loose sand is almost sterile.

SULPHUR MINES HAVE THE LARGEST OIL-BURNING POWER PLANT

The plant of the Freeport Sulphur Co. at Freeport, Tex., at the mouth of the Brazos river, is being greatly enlarged, the engineers for the work being Westinghouse, Church, Kerr & Co. of New York. The sulphur deposits underlie Bryan heights, one of the domes which dot the coastal plain. It has an area of about 500 acres, and its crest is but 28 feet above mean low tide. The sulphur-bearing horizon lies many hundred feet under the surface, surmounted by a limestone cap, the sulphur occurring in pockets and veins in a porous gypsum formation heavily loaded with water, as it is below sea level. To recover the sulphur millions of gallons of boiling water are forced into the formation under heavy pressure, searching out the sulphur and freeing it from the rock which contains it. Sulphur melts at 238 degrees F. In its melted state it is pumped by compressed air to the surface, where it is forced through piping to immense storage bins, where it congeals and builds up huge blocks of solid sulphur 99½ per cent. pure.

The largest oil-burning steam boiler plant in this country has been established at the mines to recover the sulphur. The experimental plant, known as plant No. 1, was built in 1912 and has a capacity of 3,000 boiler horse-power. Plant No. 2 was built adjoining plant No. 1 in 1914, and has a capacity of 4,000 boiler horse-power. Plant No. 3, finished this year, and plant No. 4, now under construction, are situated on the other side of the mound, and have a capacity of 8,400 horse-power each, making a total installation of 23,800 horse-power. The buildings are constructed of steel and corrugated iron on concrete foundations. Fuel oil for boiler purposes requires continual tank steamer service from the Mexican oil fields, and the Freeport Sulphur Co. owns and operates its own tank line.

The boiler water supply is obtained from a series of wells, pumped by air compressors, and is stored in two reservoirs. The mine water supply is obtained from the river through a canal 3½ miles long, and is pumped into two separate reservoirs. Both mine and boiler water are treated with calcium hydrate to remove scale-producing salts before going to the reservoirs, where the precipitation takes place. The precipitated sludge is periodically pumped from the reservoirs by a hydraulic suction dredge. A day's water supply is pumped and treated in eight hours, and 7,000 pounds of calicum hydrate are daily used in the process. As far as is known, there is no other plant in this country treating water for the removal of scale-producing salts in any such quantity.

All excess steam about the plant is used for heating water. After scale-producing salts have been removed from the boiler water there still remain salts which cannot be removed by chemical treatment and cause foaming and priming in the boilers. The concentration in the boilers is kept within safe limits by continuously blowing them off and special arrangements are made for recovering the heat from the blow-off water.

The above we have abstracted from a more detailed and complete description in Manufacturers Record, Nov. 9.

A CHANCE FOR SOMEBODY

the Compressed Air Magazine Co.
Dear Sir

I have invented a Air Motor it have Power enough to Pump water and not cost the oner a cent in Power and will do other work as well henny one can start this Motor by a turn of crank I do want some one to help me to build a large Air Motor and get it Patent in all Countrys I will allso give half to the one that will help me if you can get some one I will be please Yours truly

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - - Circulation Manager

PUBLISHED MONTHLY BY THE.

Compressed Air Magazine Company
Easton, Pa.

New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XXI. DECEMBER, 1916. No. 12

CONTENTS

Aviation Apprenticeship 8195
Roughening a Concrete Floor............8197
Blasting with Liquid Oxygen...........8198
Steam Hammers should be Air Hammers.8199
"Gassed" in the Trenches................8202
Sinking a Shaft in Norway..............8202
Air Balanced Hoisting Engine...........8205
Power from Volcanic Heat..............8207
Railway Compressor Operating Costs....8207
High Pressure Turbo-Compressors......8209
Dry Excavation of Livingstone Channel..8211
Cement Gun in Coal Mines..............8213
Dust, Sand, Wind.......................8214
Largest Oil Burning Power Plant........8216
Metric System Free to All...............8217
Tunneling Machine Demonstration.......8218
Handbook of Rock Excavation...........8218
New Publications of Bureau of Mines....8219
Sand Blasting and Scrap Glass...........8219
Good Long Distance Advertising.........8220
Turkish Irrigation Project...............8220
Air Hammer Helps Out...................8220
Pneumatic Lathe Grinder................8221
Wind Velocities and Wave Heights......8221
The Combination Shot...................8221
Notes 8222
Patents 8223

THE METRIC SYSTEM FREE TO ALL

The Philadelphia Bourse is conducting an inquiry among manufacturers and exporters as to their views on the proposed general adoption of the metric system in the United States. It has elicited, among a variety of other contributions, the following statement by Coleman Sellers, Jr., president and engineer of William Sellers & Co., Inc., machine-tool manufacturers:

"I would certainly recommend exporters to make any use of the metric system that will facilitate their foreign business, such as expressing weights and dimensions in the units used by the purchaser, if he so desires. The Bourse is to be commended for putting the necessary information before manufacturers and exporters, but I should be very sorry to see it lend itself to any propaganda designed to force the use of the metric system on the whole country by act of Congress.

"The French units have been legalized by our Government and accurate standards have been prepared for distribution. This, I think, is as far as the Government should go. I am perfectly willing that any one shall make what use of the metric system he deems desirable, but I object seriously to any attempt to force the extension of the system by legal enactment. The advocates of this course are no doubt absolutely sincere in their belief, but they approach the subject too much from a scientific point of view and do not give due consideration to the practical side. If the system is really better than ours, it will in time supplant it without the violent disturbance which would follow an enforced use.

"Our own foreign business is chiefly confined to machine tools or other machinery for working metals, and the metric system is only involved to the extent that we occasionally are required to furnish the principal screws with metric threads, or to arrange a machine to cut metric threads; that is, threads in which the lead or pitch is expressed in millimeters instead of in inches or fractions of an inch. Even this requirement is not universal. We are now building machines for Russia (a metric country) which are required to cut inch threads. It really makes no difference to the buyer of a machine whether the inch or the millimeter has been the unit of measurement used in constructing it.

"As to the use of the system in our own

establishment, I may say that when we began the manufacturing of the Gifford injector about 1860 we followed the drawings of the French inventor, using his units, and all our gages and tools were made accordingly, with the single exception that the threads for the pipe connections conform to the American standard. We have continued to use the metric units in this department since it started, with entire satisfaction, but with no desire to extend it to the rest of our establishment.

"To change a manufacturing plant such as ours from one system to the other is not so simple a matter as merely substituting a rule differently graduated, but it involves a large investment in tools and fixtures and an interference with established standards which it is practically impossible to change. This difficulty is very real, as is illustrated by the fact that even in France the metric system is not used to the entire exclusion of other standards; and in other countries, Russia for example, the English system of threads still generally prevails. The matter of thread standards is in a chaotic state in the meter-using countries, and they have not yet agreed to conform with a universal standard of diameters, pitches and forms of thread, although numerous efforts have been made to bring this about. In fact, the subject is in the same confusion that existed in England before Sir Joseph Whitworth introduced his system of screw threads which was suggested by the late William Sellers and officially approved by the Franklin Institute."

TUNNELING MACHINE DEMONSTRATION

What is claimed to have been a successful demonstration of a rock tunneling machine driven by compressed air has recently been given in the subway excavation at Grand Central Terminal, New York. According to the published statement, a tunnel 8 ft. in diameter was driven 2½ ft. through solid rock in 8 hours of elapsed time, including delays for removing muck and other purposes. For 3 hours and 57 minutes of actual running time the progress averaged 7.6 inches per hour.

This machine, which has been developed by Oliver O. App, for the Rock Tunneling Machine Co., New York, consists essentially of 14 pneumatic hammers with chisel points, fixed in a cross head mounted in a 12-inch horizontal shaft driven by a compressed air engine. Extreme variation in the hardness of the rock and the irregular resistances due to sand pockets, open seams, etc., are provided for by pneumatic control that proportions the amount of air in the hammer exactly to the resistance encountered and stops the hammer action when the resistance is very light. The machine removes the broken rock from the heading and delivers it to a conveyor that discharges into muck cars at the rear.

It may be noted that the entire class of machines of which this may be the best up-to-date representative, works on the principle of dispensing entirely with the use of explosives and breaks up the entire face of the rock by mechanical means as it advances. To assume that this can be successfully and profitably accomplished would seem to be at varience with all experience in rock excavation.

NEW BOOK

Handbook of Rock Excavation, Methods and Costs. By Halbert P. Gillette. 842 pages 5 by 7 ins., 184 illustrations, 87 tables, flexible leather. New York, Clark Book Co., $5.00.

The author of this work is a leading authority upon the subject of which he treats, and he has had exceptional opportunities for collecting precise data at first hand. The book contains all the information of present and future value originally published 12 years ago in "Rock Excavation, Methods and Costs," with about twice as much more additional material since collected and all having the same characteristics of accurate reliability and up-to-dateness . The copious cost data are perhaps the most valuable single feature of the work, and accompanying these are descriptions of a large number of methods of excavating and transporting rocks under difficult conditions which give the reader the necessary particulars to enable him to analyse and interpret the figures.

The completeness with which the entire field is covered is sufficiently suggested by the titles of the successive chapters, which are as follows: Rocks and their Properties; Methods and Costs of Hand Drilling; Drill Bits; Shape, Sharpening and Tempering; Machine Drills and their Use; Core Drills; Explosives; Charging and Firing; Methods of Blasting; Loading and Transporting Rock; Quarrying Dimension Stone; Open Cut Excavation in Rubble Quarries, Pits and Mines; Railroad

Rock Excavation and Boulder Blasting; Canal Excavation; Trench Work; Subaqueous Rock Excavation.

NEW PUBLICATIONS OF THE BUREAU OF MINES

BULLETINS

Bulletin 108. Melting aluminum chips, by H. W. Gillett and G. M. James. 1916. 88 pp.

Bulletin 126. Abstracts of current decisions on mines and mining, reported from January to April, 1916, by J. W. Thompson. 1916. 90 pp.

Bulletin 134. The use of mud-laden fluid in oil and gas wells, by J. O. Lewis and W. F. McMurray. 1916. 86 pp., 3 pls., 18 figs.

TECHNICAL PAPERS

Technical Paper 130. Underground wastes in oil and gas fields and methods of prevention, by W. F. McMurray and J. O. Lewis. 1916. 28 pp., 1 pl., 8 figs.

Technical Paper 136. Safe practice at blast furnaces; a manual for foremen and men, by F. H. Willcox. 1916. 73 pp., 1 pl., 43 figs.

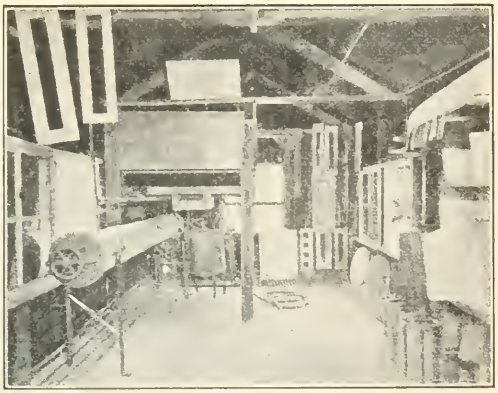
Technical Paper 146. The nitration of toluene, by E. J. Hoffman. 1916. 32 pp.

Technical Paper 157. A method of measuring the viscosity of blast-furnace slag at high temperatures, by A. L. Field. 1916. 29 pp., 7 figs.

Note.—Only a limited supply of these publications is available for free distribution, and applicants are asked to co-operate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers can not be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

Air-pressure tanks carrying over 25 lb. per sq. in. are to be inspected biennially by the California Industrial Accident Commission There was one fatal accident in 1915, 6 permanent and 343 temporary injuries.

There are 1,525 miles of cast-iron pipe in service in Baltimore, some of which has done duty for 111 years, states the Cast Iron Pipe Publicity Bureau, New York City. "Exceptional endurance, little or no depreciation—that's cast-iron pipe."



GLASS SAND BLASTING ROOM.

SAND BLASTING MAKES SCRAP GLASS USABLE

The portable sand blasting plant installed by the Northern Ohio Traction & Light Company, Akron, Ohio, in addition to performing its usual functions, has been found to be useful for making clear scrap glass usable. Both clear and Florentine glass are used in this company's cars, the latter serving exclusively in the deck sashes and door panels. Since both of these are of small dimensions, it frequently occurs that there is clear scrap glass which could be used at these points if it were chipped. The chipping is accomplished by applying one coat of cheap glue to the sand-blasted clear glass. The glue in drying curls and chips the surface of the glass, and to hasten this drying process electric heaters are frequently used. The margins of this chipped glass are left sanded and, in some instances, as in the case of the door panels, the lettering is sand blasted on the glass. This sand-blast equipment is also used for lettering clear glass, for such signs as "Have Your Fare Ready," "No Smoking," "Passengers Must Not Talk to Motormen," or any others which may be readily displayed on the sashes and glass door panels.

At first a home-made sand-blasting outfit was provided, but so many useful things could be accomplished by sand blasting that a special outfit was purchased from the American Foundry & Equipment Company. As a general proposition the sand-blasting is done in a building especially provided for that purpose, which is shown in the accompanying illustration. All work that can be brought to the sand-blasting plant is handled in this building, but when it is necessary to sand-blast cars in the paint shop the outfit is moved to that point. The operation of the sand-blasting equipment is in charge of the upholsterer, as it is only required two or three days a month. Whenever the stock of sand-blasted or Florentine glass becomes low, he replenishes it, and as occasion demands, performs other sand-blasting operations.—*Electric Railway Journal.*

GOOD LONG DISTANCE ADVERTISING

Here in the United States, says a writer in the current number of *The Nation's Business,* are fully 2,000 students from the republics of Latin America; 1,500 from China; 1,000 from Japan; 500 from the Philippines, and hundreds from Russia, the near East and India. There are 275 at the University of Pennsylvania; 300 at Cornell; 400 at Columbia; 250 at Michigan; 300 at Illinois; 150 at Wisconsin, and 300 at California. At least 400 are enrolled in the various institutions in Chicago. They represent wealth and influential families and industries. After three to six years of study they will return to positions of power in their home countries. A majority of the foreign students are studying engineering, industrial chemistry, banking, commerce, and business administration; they are introduced to the latest inventions and the most modern appliances used by the mechanical and electrical engineer, the chemist and banker. After four to six years of experience with articles used in American business, it stands to reason that the foreign student will insist on the introduction and use of articles which he has tested and proved satisfactory. No such opporpunity for the expansion of foreign trade has heretofore been presented to the North American business man. It is good business, good ethics, and good diplomacy to win their friendship.

TURKISH IRRIGATION PROJECT

From an engineering viewpoint the Old World, especially the oldest portions of it, is still far from finished. A project for the irrigation of the Adana Plain (the ancient Cilicia), to cost over $17,000,000 and to require from eight to ten years for completion, has been undertaken by the Turkish Government. It is proposed to regulate the course of the three rivers which water the plain—the Saihun, Shihan, and Berdan Shah—and thus open up to agriculture a tract of nearly half a million acres, much of which is at present arid. It is estimated that the completion of this irrigation project and the introduction of fertilizers and up-to-date agricultural machinery will greatly increase Turkey's production of cotton, sugarcane, lemons, oranges, and olives. A part of the irrigation works will be put into operation during the next eighteen months. After the irrigation project becomes a reality the Adana Plain will be the garden spot of the Ottoman dominions. It already possesses excellent transportation facilities, being traversed by the Bagdad Railway and having connection by rail from Adana to Mersina. Furthermore, the important Port of Alexandretta is only thirty miles from the mouth of the Shihan River, which, as well as the two other watering the plain, will be made navigable and will offer a cheap means of transporting the products of the plain to the sea. The regulation of the three rivers will also provide abundant water power for industrial purposes.

AN AIR HAMMER HELPS OUT

After turning out several hundred thousand of a certain part on an outside order, a manufacturer of forgings found that the drawing given him was wrong, and that a certain boss, instead of being 2¼ inches wide, as it had been made, should be only 1⅞ inches, to allow it clearance between two fixed points in the machine in which it was to be used. The discovery was made when the first carload shipment came back from the buyer, and work was practically completed on the contract then. The work of reducing the bosses was started under one of the hammers, but took up so much time, and required so much work that the shop schedule was being disarranged. An air hammer was therefore mounted on a heavy post, and a heavy anvil set up so that it would allow the proper clearance over the work. Then, with a separate furnace to heat the reworking pieces, the air hammer, with a foot control on the valve, was found to work the stock down without any where near the power consumption of the big hammer being used on the job, and the light machine served to dress the four sides of the boss well enough for the first lot sent back to the buyer to appear as new work—and to bring a vigorous protest from him that he would not pay for the remaking of his order. When he found all he delegated to turn the crank. The blower forces a considerable quantity of air into the bottom of the manhole, which displaces the gas and supplies fresh air to the workmen. In particularly bad instances a continuous operation of the blower has enabled work without danger of asphyxiation.

WIND VELOCITIES AND WAVE HEIGHTS

Some observations were made during the year 1915 on the Belle Fourche Reservoir of the U. S. Reclamation Service to determine the height of waves under various wind velocities. A wave gage was erected well out in the water and a recording anemometer was installed. The height of waves from crest to trough was observed during various periods of high wind velocity, the results being as follows:

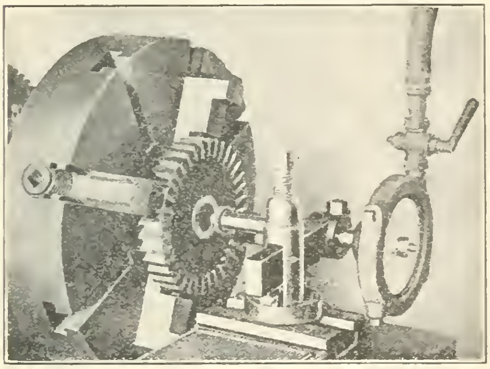
Date.	Wind velocity, miles per hour.	Wave height, feet.
Aug. 28	35	2.0
Sept. 8	40	2.5
July 4	44	2.5
May 16	48	3.5
Oct. 7	50	3.5
June 12	56	4.0
Oct. 24	75	5.0

The fetch of the wind was approximately 5 miles for all observations, and the depth of water during the entire period varied but 3 ft., the mean depth at the gage being approximately 10 ft.

THE COMBINATION SHOT

In some of the coal mines of this country, especially those in the anthracite field, the practice of making what is known as "the combination shot" is common. It is so called because a charge of dynamite and a charge of blasting powder are used in the same bore hole. The blasting powder is ignited either by fuse or miner's squib, the explosion and heat of the blasting powder being depended upon to detonate the dynamite. The miner believes that by loading holes in this manner he is assured that the hole will break clear to the point, on account of the extra strength and extreme quickness of the dynamite. Laws have been passed and are still in the mining laws prohibit-

was being taxed for was the reconstruction—and that it ran less than half of what first estimates had led him to expect, he was mollified.



PNEUMATIC LATHE GRINDER

The half-tone shows a grinder of novel type mounted on a lathe carriage with the emery wheel on the end of the spindle in position for grinding out the hole in the milling cutter mounted in the chuck. As the work is rotated in the lathe the grinding wheel is fed into the hole and back again by the regular carriage feed. This grinder can be used also for external grinding on work projecting from the face-plate. It is also used for truing the lathe centers and other purposes.

An interesting feature of this device is the motor, which is similar in principle to a Pelton water wheel, a jet of air impinging upon a series of blades on the periphery of a disk and producing, in this case, a speed of about 2,000 revs. per min. The grinder is made by Wm. B. Mershon & Co., Saginaw, Mich.

EXPELLING GAS AT STREET MANHOLES

In underground cable work manholes are encountered in which the gas is so bad that it is practically impossible for men to work in them. If the work to be done is of an urgent nature and time cannot be taken to wait for the gas company to repair the leak causing the trouble, special means of ventilating the manhole is essential. The Commonwealth Edison Company of Chicago has made successful use of standard Lancaster geared-type blowers for this purpose. A 10-ft. length of 3-in. hose is connected to the blower and inserted in the manhole and one of the helpers ing the making of combination shots, but the reprehensible practice is still employed by the miners to a considerable extent, with or without the assent of the operators. According to the best authorities and theory, the combination shot is both dangerous and inefficient.

NOTES

Producing nowadays at a rate of 1,000,000 lbs. of copper a day, Anaconda Copper Co. enjoys the distinction of being the world's largest copper producer. With costs of producing around 11 cts. the company is earning, basing production on 300,000,000 lbs. annually and a 25 ct. market, no less than $18 per share annually.

It is reported that flying from the trenches in France to London and back again in the same day is becoming a not uncommon experience for officers of the British Army. The story is told of how a soldier recently left the trenches in France early in the morning, took a Turkish bath in London some three and a half hours later, lunched at one of the leading hotels in the British metropolis, and returned back to the trenches in the early evening.

A new equipment for killing condemned horses with illuminating gas has been installed in the Denver City Pound. A small air-tight stall is connected with the city gas-main. While the horse is munching his oats or hay from a manger in one side of the stall, the gas enters from a pipe directly underneath. The animal gently and peacefully subsides into insensibility.

From 50 to 75 gals. of distillate, a by-product of tar, from which aniline dyes and products used in manufacturing explosives are obtained, are being produced daily at the Ogden Pintsch gas plant at Ogden, Utah.

In an effort to reach entombed men in the mine of the Jamison Coal and Coke Company, at Barrackville, W. Va., Lewis M. Jones, one of the Bureau of Mines mining engineers, was overcome and died before he could be removed from the mine.

The biggest natural bridges in the world are to be found in the United States. The largest of these, the Rainbow, 308 feet high, would span the dome of the United States Capitol, with room to spare, and is nearly as high as the Flatiron building in New York. Its span is six times as great as that of the Natural bridge of Virginia. Utah alone has three natural bridges that are higher and of greater span than any other natural bridge in the world.

A mine explosion at Marvel, Ala., on Oct. 22 caused the death of every man in the mine of the Roden Coal Co., except one—17 men. The one who escaped was a pumpman in one of the upper headings. All the men killed had gone into the mine to install a new electric-feeder cable. Open lights were used, but up to this time the mine had not been considered gassy. The United States Bureau of Mines mine-rescue car was sent to the scene of the explosion, but by the time it arrived gas helmets were no longer necessary.

The following are the leading particulars of the super-Zeppelin L-33 which was brought to earth in England on September 23: Length, 680 ft., total weight with crew and officers 50 tons; six 240 horse-power engines with a speed of 1,600 revolutions per minute, three engines being placed in one gondola and one in each of the others; estimated quantity of petrol carried 2,000 gallons, and gas capacity of the envelope 2,000,000 cubic feet. The vessel carried seven or eight guns, including five Maxims and sixty bomb droppers.

The largest dam in Europe has recently been completed by American engineers, near the old fortified town of Talarn, in Spain. The Noguera Pallaresa River flows through the chasm where the dam is built with cliffs nearly vertical on either side. The dam is 330 ft. high, 700 ft. long, 230 ft. through at the base, decreasing to 14 ft. at the top. The lake formed by the impounded water will be 15½ miles long and 3¾ miles wide. The water will be carried by a system of canals into an arid district to irrigate a surface of nearly a hundred square miles. A large horse-power also will be developed.

The proportion of machine-mined bituminous coal to the total putput has increased each year. In 1915 the proportion was 55 per cent., twice that of 1903, twelve years before, and the number of tons so mined in 1915 was more than three times that in 1903. It is interesting to note that among the nine States ranking highest in order of bituminous production—that is, producing 8,000,000 tons or more—all but two, Alabama and Colorado, showed more than half mined by machines; and that among all the other States only two, Montana and Michigan, recorded like proportions.

The calorific value of illuminating gas, so-called, and not its candlepower has been established as the standard by the Public Service Commission for the Second District, State of New York. All companies making more than 20,000,000 cu. ft. per year of coal, water or mixed gas must show a product averaging 585 B.t.u. per cu. ft. The change has been made to accord with the development of the gas industry, which is toward consumption in bunsen-burner apparatus, where the usefulness depends on heat content and not on candlepower of an open flame. The cost of oils introduced into ordinary gas to raise the candlepower has greatly increased as the utility of the enrichment has diminished.

In the Bureau of Yards and Docks of the United States Navy the problem of designing flag poles led to a study of the pull of flags of different dimensions and under different wind velocities. Two sizes of flags were used, one a No. 7, 3x5½ ft, the other a No. 8, 2½x4¼ ft. The flags were tried in wind velocities of from 20 to 60 mi. per hr. and the results show that the total horizontal resistance of a flag, exposed to a steady current of air, can be approximately represented by the formula $R = CAV^{1.9}$, where R = the resistance in pounds, A = area in sq. ft., V = velocity of wind in mi. per hr., $C = 0.00030$. The value of C decreases slightly with the size of the flag; that is, the resistance per square foot of area decreases slightly with the increase of size.

The New York up-state commission has decided that the use of compressors on natural gas lines cannot be restrained by the commission. If the use of compressors injures landowners who lease gas wells to a company using the compressor, the remedy lies with the courts and not with the commission. Commissioner Hodson reviews the contention of the complainants that compressors make the gas flow faster from wells than it would under natural conditions, but points out that the experts of the companies gave the more convincing proof that compressors do not increase the amount of gas drawn from wells, but merely boost the pressure to a degree necessary for its transmission. The ground for denial of the complaint however, is that the commission is without jurisdiction.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 3.

1,199,772. VACUUM-BOTTLE. John J. Engel, Pittsburgh, Pa.

1,199,792. ELECTRO - PNEUMATIC ORGAN-VALVE. Robert Hope-Jones, deceased, North Tonawanda, N. Y.

1,199,804. AIR-MOTOR. Charles McGregor, Derry, N. H.

1,199,807. MOTOR APPARATUS. Calvin A. Miller, Ellsworth, Pa.

1,199,838-39-40. FLUID - PRESSURE BRAKE APPARATUS. Walter V. Turner, Edgewood, Pa.

1,199,847. AUTOMATIC PRESSURE - REGULATOR. Thomas M. Wilkins, East Randolph, N. Y.

1,199,900. PRESSURE - REGULATING DEVICE. August Kadow, Toledo, Ohio.

1,199,904. FLUID SPEED-CHANGING GEAR. Milton A. Kettler, Washington, D. C.

1,199,910. AIR CUSHION OR SPRING. Peter A. McCullough, Pittsburgh, Pa.

1,200,170. FLUID - COMPRESSOR. William F. Collins, Pasadena, Cal.

1,200,371. VACUUM - PRODUCER. Waclaw Kossakowski, Chicago, Ill.

1,200,402. APPARATUS FOR LIFTING LIQUIDS. James M. Wasson and Michael E. Cahn, New Orleans, La.

1. Apparatus for lifting liquids, comprising a cylindrical casing, an air pipe projecting down into said cylindrical casing and provided with a series of tangentially disposed curved expanding nozzles projecting therefrom, and means for supplying compressed air to said air pipe, substantially as described.

1,200,446. AIR-SPRING. John G. Funk, Swissvale, Pa.

OCTOBER 10.

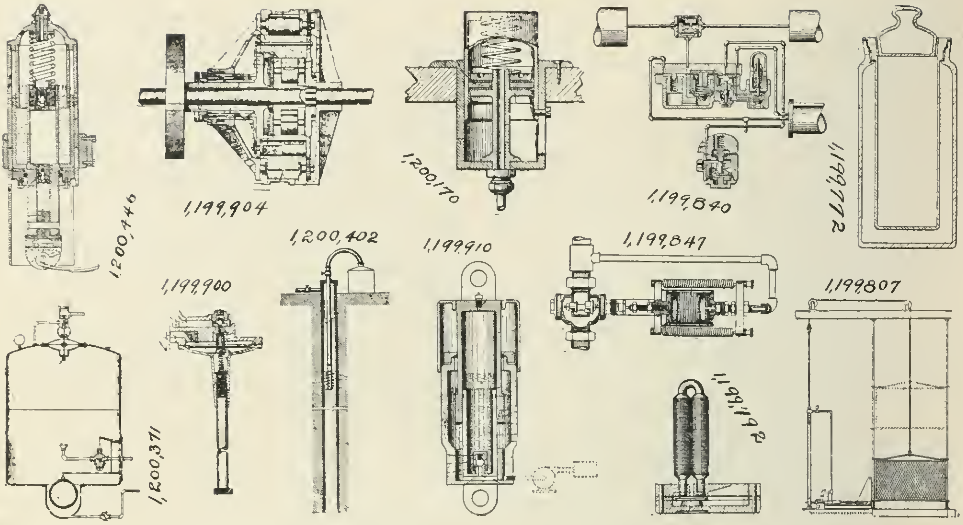
1,200,469. SAND-BLAST MACHINE. John L. Dawes, Pittsburgh, Pa.

1,200,541. COMPRESSED-FLUID STARTING APPARATUS FOR INTERNAL-COMBUSTION ENGINES. Frank E. Ten Eyck, Auburn, N. Y.

1,200,572. VALVE FOR GAS AND LIQUID MEASURING DEVICES. Edward August Appell, New York, N. Y.

1,200,699. CONVEYER. George Bernert and Jacob Bernert, Milwaukee, Wis.

The combination of a blower fan and a hopper disposed below the top of the fan, a blower trunk associated with the fan and extending upwardly directly therefrom, a conveyer casing extending upwardly from the hopper and communicating with the blower trunk above and adjacent the fan and a conveyer in the casing.



Pneumatic Patents October 3.

1,200,720. APPARATUS FOR CONTROLLING THE FLOW OF FLUID. Joseph Barbe Fournier, St. Mande, France.

1,200,859. FLUID-PRESSURE REGULATOR. Leon P. Lowe, San Francisco, Cal.

1,200,869. AERATION AND SUBIRRIGATION FOR PROMOTING VEGETATION. Archibald Henry Rife, San Antonio, Tex.

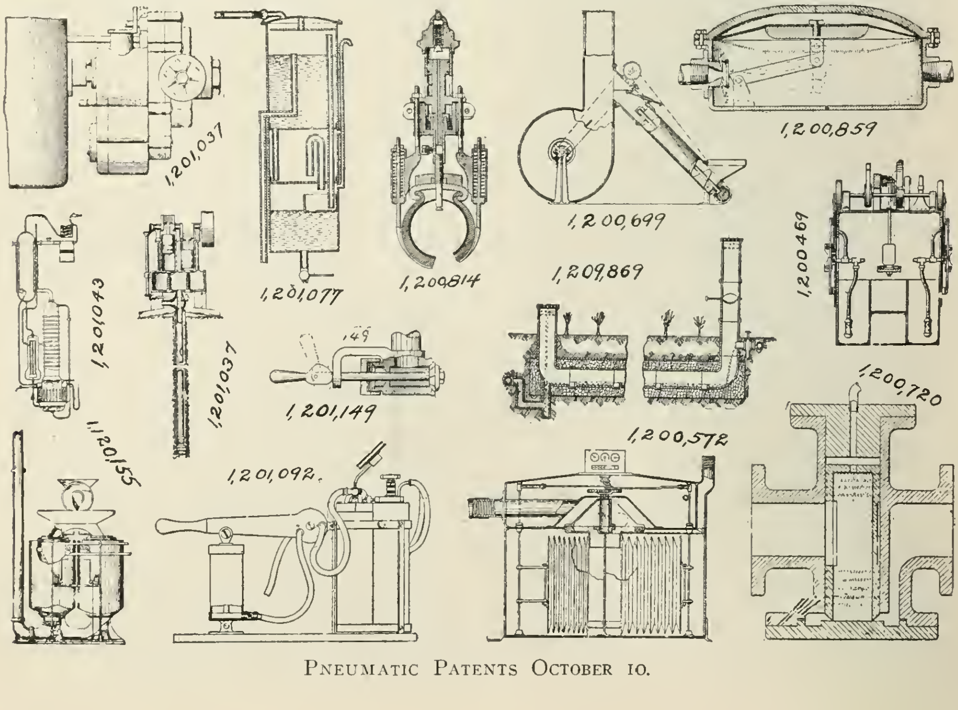
1,200,874. DEVICE FOR AUTOMATICALLY INFLATING AUTOMOBILE-TIRES. George E. R. Rothenbucher, New York, N. Y.

1,201,037. COMBINED AIR STARTER AND COMPRESSOR. Edward E. Gray, Plano, Ill.

1,201,043-4. APPARATUS FOR DIVIDING AIR INTO ITS ELEMENTS BY FRACTIONAL DISTILLATION. Maurice Hazard-Flamand, St. Vrain, France.

1,201,073. PUMP. William L. Morrow, Los Angleles, Cal.

1. In a pump, the combination of means providing a source of compressed air, a receptacle for liquid to be pumped, an inlet valve for liquid in said receptacle, an unobstructed discharge conduit of less volume than said receptacle having a free connection therewith forming a play pipe, an air conduit connected to said receptacle



Pneumatic Patents October 10.

and means, an air valve disposed in said conduit having a port leading to said means, a port leading to a source of low pressure, and a timing mechanism for continuously operating said air valve to alternately connect said receptacle to said source of compressed air and said source of low pressure.

1,201,077. FUEL-FEEDING DEVICE FOR AUTOMOBILES. William H. Muzzy, Dayton, Ohio.

1,201,092. ARTIFICIAL-BREATHING APPARATUS. Thomas H. Phillips, Baltimore, Md.

1,201,126. SAND-TRAP. William H. White, Roanoke, Va.

1,201,149. FORCED-DRAFT BLOWER. Wilber G. Collinge, Portland, Oreg.

1,201,155. METHOD OF AND APPARATUS FOR CONVEYING AND MIXING CONCRETE. Alfred H. Daehler, Los Angeles, Cal.

1,201,650. AIR-COOLING DEVICE. Mertie Thiers, Wichita, Kans.

1,201,660. WATER-DISTRIBUTING APPARATUS. Edward H. Weatherhead and Theodore H. Schutt, Cleveland, Ohio.

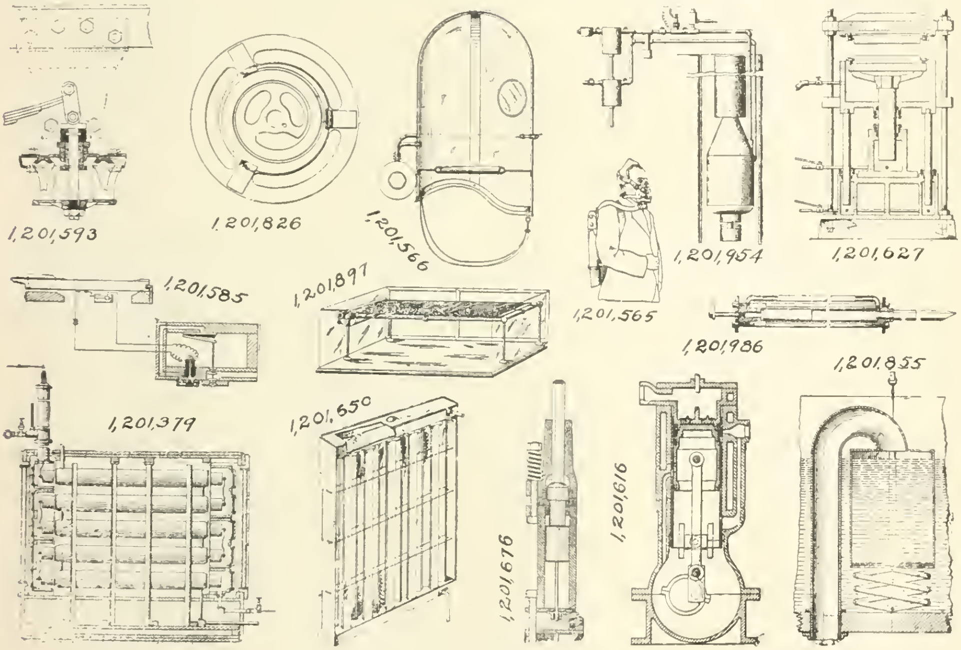
1,201,676. WATER-HEAD FOR FLUID-OPERATED PERCUSSIVE TOOLS. Lewis C. Bayles and Albert H. Taylor, Easton, Pa.

1,201,705. INTERCOOLER FOR AIR-COMPRESSORS. Charles Day and George E. Windeler, Stockport, England.

1,201,724. THROTTLE-VALVE FOR ROCK-DRILLING ENGINES. Charles C. Hansen, Easton, Pa.

1,201,826-7. VALVE FOR BLOWING-ENGINES, &c. Lorenz Iversen, West Homestead, Pa.

1,201,855. SIPHON-VALVE. William Muir, New York, N. Y.



Pneumatic Patents October 17.

OCTOBER 17.

1,201,306. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Vern L. Jones, Detroit, Mich.

1,201,379-80. APPARATUS FOR THE PRODUCTION OF OZONE. Jan Steynis, Bay Shore, N. Y.

1,201,565-6. RESCUE APPARATUS. Alfred E. Davidson, Newark, N. J.

1,201,585. ELECTROPNEUMATIC ORGAN-VALVE. Robert Hope-Jones, North Tonawanda, N. Y.

1,201,593. PNEUMATIC SHOCK-ABSORBING DEVICE PARTICULARLY APPLICABLE TO VEHICLES. Edward Brice Killen, London, England.

1,201,616. AIR-COMPRESSOR. Harleigh Parkhurst, Walpole, N. H.

1,201,627. PROCESS OF AND APPARATUS FOR REMOVING INFLATED ARTICLES FROM MOLDS. Fred Thomas Roberts, Cleveland, Ohio.

1,201,647-8. METHOD OF AND APPARATUS FOR BALANCING AIRCRAFT. John P. Tarbox, Washington, D. C.

1,201,897. AIR-MOISTENING APPARATUS. Roland Wallace, Washington, D. C.

1,201,954. PUMP. Charles Henry Fox, Bakersfield, Cal.

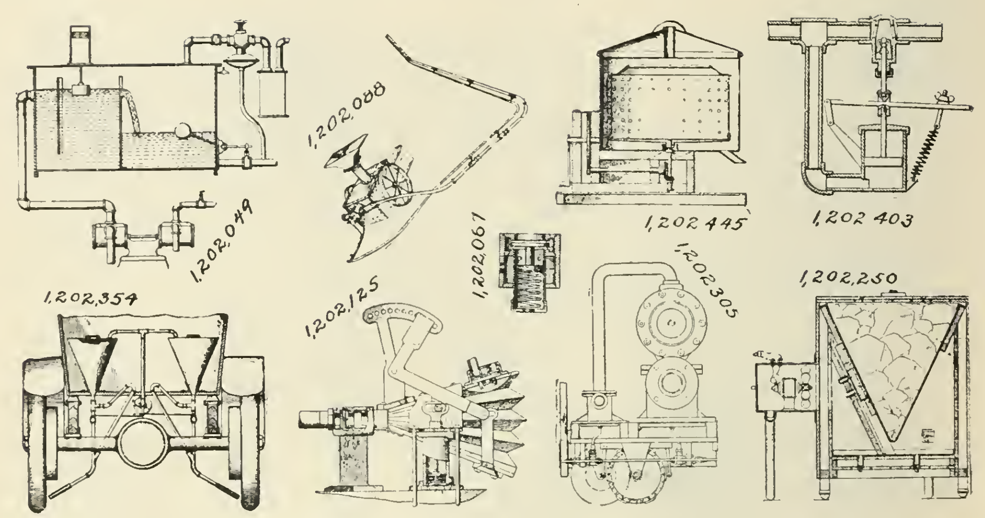
1. In an apparatus for raising water from wells or other places, a pump cylinder adapted to be immersed in the water, a reciprocatory piston in the pump cylinder provided with a valve controlled by the piston and in turn controlling the outlet of the pump cylinder, means for introducing an explosive mixture into the pump cylinder on the valve side of the piston, and means for supplying air under pressure to the pump cylinder on that side of the piston remote from the valve.

1,201,986. PNEUMATIC RIVET-BREAKER. Stonewall J. Sedinger, Indianapolis, Ind.

OCTOBER 24

1,202,049. LIQUID-MEASURING APPARATUS. Joseph W. Gamble, Philadelphia, Pa.

1,202,067. AUTOMATIC AIR-VALVE FOR EXPLOSIVE-MOTORS. Clayton Hulslander, Elmira, N. Y.



Pneumatic Patents October 24.

1,202,088. PNEUMATIC CONVEYER. John D. Murray, San Francisco, Cal.

1,202.125-6. APPARATUS FOR PRODUCING ARTIFICIAL REPIRATION. William E. Tullar, Chicago, Ill.

1,202 157. PNEUMATIC SPRING. Andrew B. Burt, San Francisco, Cal.

1,202,250. APPARATUS FOR DEHUMIDIFYING, PURIFYING, AND COOLING AIR. Luke Usher, Los Angeles, Cal.

1,202,258. AUTOMATIC AIR-COUPLING. Ira W. Armstrong and Charles A. Plamadore, Belvidere, Ill.

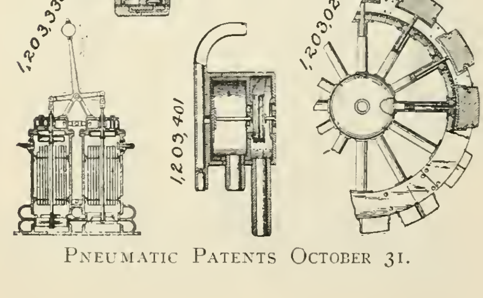
1,202,305. SOUND-PRODUCING DEVICE FOR FOG-SIGNALING, POSITION - LOCATING, AND THE LIKE. John Pell Northey, Toronto, Ontario, Canada.

1,202,354. ANTISKIDDING APPARATUS FOR AUTO-CARS, &c. William C. Bell, Winnetka, Ill.

1. The combination with an auto-car or the like, of a sand-box supported thereby, a discharge-pipe leading downward therefrom, valve controlled means for introducing air-pressure into said sand-box, a valve in said discharge-pipe, devices extending into the body of said car for operating said valve, a system of pipes the ends of which are connected to said discharge-pipe and which make a detour around said valve, and means extending into the body of the car for operating said valve.

1,202,403. PRESSURE - REGULATOR. John R. Miller, San Dimas, Cal.

1,202,445. DRYING AND AERATING MACHINE. Jonas Albert Sparks, Elk City, and Leslie C. Waters, Columbus, Kans.



Pneumatic Patents October 31.

OCTOBER 31

1,202,864. REFRIGERATION-COMPRESSOR. Walter R. McGinnis, St. Louis, Mo.

1,202.871. TRACK-SANDER. Otto William Meissner, Montreal, Quebec, Canada.

1. In a track sander, a pressure retaining sand box, a sand ejecting device, means for supplying air pressure to the sand ejecting device and building up a back pressure in the box and means for removing the back pressure at substantially the same instant that the air pressure is shut off from the sand ejecting device.

1,202,932. PUMP. Elmer A. Watts, Springfield, Ohio.

1. In a mechanism for raising fluids, a pair of superimposed elongated chambers communicating with each other and provided with heads, a compressed air passage extending through the head of the upper chamber, a passage connecting the same with the lower head, exhaust passages in said heads, valve controlled portions in each head connecting the chambers with said compressed air and exhaust passages, compressed air means within each head for actuating the valves of the heads, and means in each chamber controlled by the rise and fall of fluid therein for actuating said compressed air means.

1,203,024. PNEUMATIC WHEEL. Eli C. McCartey, Littleton, Ill.

1,203,078. FLUID-PRESSURE BRAKE APPARATUS. Walter V. Turner, Edgewood, Pa.

1,203,284. ROCK-DRILL. Daniel S. Waugh, Denver, Colo.

1,203,335. AIR-COMPRESSOR. Stirling B. Hill, Seattle, Wash.

1,203.401. PNEUMATIC PIANO-PLAYER ACTION. Joseph Pospisil, Newark, N. J.

TJ
981
C7
v.21

Compressed air

[redacted]

ENGINEERING

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

ENGIN STORAGE